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THE SHIELD-BACKED KATYDIDS OF THE GENUS IDIOSTATUS

BY

DAVID C. RENTZ

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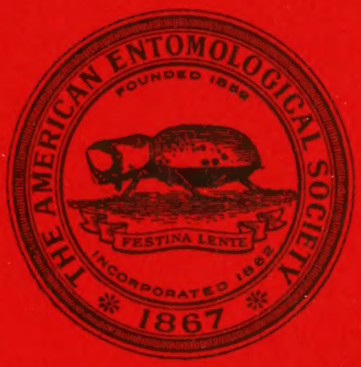

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EDITOR

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THE SHIELD-BACKED KATYDIDS OF THE GENUS IDIOSTATUS

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DAVID C. RENTZ

Academy of Natural Sciences of Philadelphia

INTRODUCTION

This is a detailed taxonomic study of twenty-four species of the largest known genus of Nearctic Decticinae — the genus *Idiostatus*. Field surveys by this author have covered a span of ten years with well over 100,000 road miles traversed in quest of these katydids. As a result a considerable amount of information on mating behavior, biology and ecology has accumulated. Some of the results have already been published, Rentz (1972). The purpose of this paper is primarily to present keys and descriptions to aid in the identification of these insects. They are of considerable concern to agriculturalists and range managers of the western states because of the damage done by the katydids during outbreak years.

The geographic range of *Idiostatus* includes the Great Basin north and west of the Colorado-Green River system west to the Pacific Coast. They do not occur on the Channel Islands of California. The distributional pattern of *Idiostatus* species is fragmented by mountain ranges, valleys, and deserts. Species have adapted to a variety of environments from coastal to montane and arid rangeland. Arid land species have adapted to the frequent occurrence of drought years by undergoing a prolonged egg diapause of at least one year's duration (see

discussion, *I. elegans, I. bechteli*). The mechanisms involved in maintenance and breaking of egg diapause are now being studied. In addition, species from xeric environments are usually thamnophilous (bush-dwelling) and nocturnal, two presumably derived biological features for optimal success in an arid habitat.

Several aspects of the present study are fragmentary due to the limitations of time and equipment, thus, information on the song patterns and chromosomal analysis are not complete and these topics are still being investigated. It is hoped that this work will be a foundation that others besides myself may build upon.

Historical Review

The first species of what is now defined as *Idiostatus* was described by Thomas (1875) as *Steiroxys hermannii*. The type series of this species was collected on the western surveying mission of 1873 conducted by the Army Corps of Engineers. Thomas noted the peculiar structure of the cerci but placed it in *Steiroxys,* the closest relative of *Idiostatus,* because of its size and overall similarity with species of that genus. Pictet (1888) proposed *Idiostatus* basing it upon a single species, *I. californicus,* which he had represented by one (possibly a series, see discussion, *I. californicus*) or more specimens from an undetermined locality in California. *S. hermannii* was not included in *Idiostatus* at that time and, for some unstated reason, *I. californicus* was relegated to synonymy with *S. hermannii* by Scudder (1894). This position was accepted later by Caudell (1907) and Hebard (1934). Scudder apparently believed that *I. californicus* and *I. hermannii* represented the same species even though the illustrations presented in the original descriptions clearly showed differences in genitalic structure. Thomas' type material of this species, as with much of his other descriptive series, was lost prior to Caudell's work and no other specimens were available. Since that time no one has questioned this placement and as a result the two have been held in synonymy. Incidentally, further confusion was added by Caudell (1907) when he stated that the type ". . . of *hermannii* seems lost, not having been found in any of the collections studied by me. The Scudder collection contains one male specimen from Mount Shasta District, California, labeled *I. californicus,* by Scudder." From that point to the present Mt. Shasta has been considered the type locality of *I. hermannii* when

in fact that species is a Great Basin inhabitant. Mt. Shasta is considered to be the type locality for *I. californicus* (see discussion, *I. californicus*).

Cacopteris was first proposed by Scudder (1894) but no species were included. He later (1899) formally defined the genus designating *C. aequalis* (= *I. aequalis*) as the type of the genus and including 7 species in it. Six of these were placed in *Idiostatus* by Caudell (1907) with *C. ephippiata* being removed and assigned to *Eremopedes*. Subsequently *C. sinuata* was placed in *Eremopedes* by Hebard (1934). The status of *Cacopteris* as a generic unit was challenged by Caudell (1907) who stated "The synonymy of Scudder's genus *Cacopteris* with *Idiostatus* is very certain as a type of *Cacopteris*. *C. aequalis,* has been seen and compared with the type of *Idiostatus* and found to be generically similar." Later Rehn and Hebard (1920) stated "We do not believe *inermis* Scudder, genotype of *Cacopteris,* to be congeneric with *californicus* Pictet (= *hermannii* Thomas), genotype of *Idiostatus*. We therefore consider *Cacopteris* a valid generic unit." One serious point in the above is the assertion that *C. inermis* is the type of the genus *Cacopteris*. Scudder unambiguously designated *C. aequalis* as the type but this has been misinterpreted by Kirby (1906) in his catalog where he states that *C. inermis* is the type of *Cacopteris*. Another interesting aspect of the above quotation was the continuation of the incorrect synonymy of *I. hermannii* with *I. californicus*. Later Hebard (1934) emended Rehn and Hebard's 1920 decision to resurrect *Cacopteris* stating "After detailed study of the ten valid species involved we find that Rehn and Hebard were incorrect in believing that more than one recognizable genus was represented and, therefore, we now concur with Caudell who in 1907 placed *Cacopteris* Scudder 1894 as a synonym." He also corrected the error made with regard to the type species of *Cacopteris*.

Caudell (1908), in the Genera Insectorum, reviewed a world-wide assemblage of Decticinae, although a small sample and now well out of date due to the vastly increased number of species. He divided the subfamily into 5 groups, *Idiostatus* falling into group 4 with 17 other genera, some related, most others not. The group Dectici was characterized by an unarmed prosternum and posterior tibia with 4 apical spurs on the ventral surface. The group consisted of both old and

new world forms, one of which, *Tettigonia,* is the nominate form of the related subfamily Tettigoniinae. Caudell listed the known species of *Idiostatus* noting the original citations and type localities. A male of *I. elegans* was illustrated in color.

Although no revision of *Idiostatus* has appeared to date, descriptions of new species were added by Caudell (1907), Rehn and Hebard (1920), Hebard (1934), Caudell (1934). A few others have commented on the bionomics or systematics of various species.

Uvarov (1928) in discussing the relationship of the genus *Bergiola* noted the degree of similarity between that genus, then consisting of *B. balchaschica* (Stschelk.), the type of the genus *B. mongolica* Uvarov, *B. daurica* and *B. persica,* with *Idiostatus.* He believed that *I. hermannii* (likely represented by *I. californicus*) was the nearest relative of *Bergiola.* Hebard (1934) characterized the species of *Idiostatus* but erred in commenting "In all species of which the females are known, the distal margins of the ovipositor are very minutely but definitely denticulate, this distinguishing them from all other known species of the North American Decticinae." Both subgenera of *Neduba* (*Neduba* and *Aglaothorax*) possess this feature in all species. Nearly all of the species of *Steiroxys* which I have examined also possess the condition described above. Tinkham (1944) reviewed the decticines of the North American deserts and made comments. Since the Hebard and Caudell works of 1934, no new species have been added to *Idiostatus.*

Methods and Techniques

Format. — The procedure followed in this paper is somewhat similar to that of Cohn (1965). The Species Treatment section is divided into subsections which will allow the reader to find the part of interest to him. The Type Data section quotes exactly what is on the type label and not the published type locality statement. The Type Locality section interprets the data associated with the type and comments on the published type locality. The diagnostic comparisons are best utilized when comparing species within the given species group. Other sections are self-explanatory. Species descriptions are treated in the following manner: new species are described in the following fashion: holotype and allotype described separately followed by a section on intra-specific variation: poorly known species

are treated as are the new species; the better known species are fully redescribed in the broad sense, with notes on the unique features of the holotype preceding the species description. All figures are greatly enlarged but the magnifications are not always the same. Locality data included in tables and illustrations may be found in greater detail in the appropriate section of the species treatment. Unless otherwise indicated, plant communities are discussed as defined by Küchler (1964).

Terms. — Throughout this paper the term "phaneropterine green" may be found where appropriate. This was first used by Rentz and Birchim (1968) to denote the uniquely tettigoniid green color found in most of the bush katydids of the subfamily Phaneropterinae. Reference is made to the "mating platform" in the discussion of mating behavior of many species. This is merely a wire screen (Pls. 11-18) used in the laboratory by the insects during observational mating sequences. Some type labels will be noted "genitalia in permount, solvent toluene." This refers to the manner in which the titillators are preserved with the specimen. Mr. Wayne Gagné suggested that such two dimensional structures be preserved in a mounting medium such as permount with the pinned specimen. The method has been successfully utilized by Shinn (1963) in preserving entire insects. A small cover-slip of the same acetate material can be applied using a conductor's punch. I have found this quite useful and a more permanent way to keep critical structures than the use of genitalia vials and glycerine which may not last as long and may in time change the structure.

Chromosome numbers. — The chromosome complements of many species of Nearctic Decticinae are currently being studied and when known for the different species of *Idiostatus* are included following the descriptions. For chromosome studies adult or last instar males were taken alive and their testes removed and placed in a mixture of 100% isopropyl alcohol and glacial acetic acid in a 3 to 1 ratio. Material preserved in this manner was found to be useful in cytological examination for several years after original fixation. Due to the paucity of data at this time, little can be hypothesized about the relationships of the species based on chromosomal evidence.

Measurements. — All measurements have been made either with

Vernier calipers or with an ocular micrometer in a stereoscopic dissecting microscope. The points on the organs between which the various measurements were taken are based on the standard set by Cohn (1965) in his figure 2. Tables 3 to 9 present a summary of the measurements of each species (and geographical variation). Only ranges are given, these are rough indices of absolute and relative size relationships among or within the species. The samples are not random, collecting being concentrated in certain regions and not in others. Some regions were not sampled. Parametric descriptions, such as means and standard deviations in measurement data would therefore be misleading. Egg measurements may be somewhat misleading due to dehydration. All measurements given in this paper are in millimeters.

Collecting. — In the past, collection of decticine katydids by orthopterists was usually accomplished at night; by following the call of a singing male and after a considerable time, if successful, locating and collecting the specimen. This technique usually results in small numbers of katydids mostly males and few or no females. Diurnally mating species were obtained in the same manner but with somewhat more rewarding results. Bush trampling had its value but the effect on the vegetation was obvious and undesirable. I have utilized these methods but have found other techniques more productive. In July, 1968 slowly driving Highway 140 from Denio Junction, Nevada, northeast for 5 miles proved a most fruitful technique for that area. On the surface of the highway I found 3 species of Decticinae, 2 of which were new species of *Idiostatus* (*I. inermoides, I. apollo*) described elsewhere in this paper. This method, well known to herpetologists, yields other information as well. One can examine the geographic distribution of a given population and record its limits; an indication of intra- and inter-specific abundance can be readily observed; nocturnal activity periods can similarly be recorded.

Since the nomadic tendencies of decticine katydids is not directly related to diurnal or nocturnal mating behavior, not all species of *Idiostatus* may be obtained in the manner described above. Species of the *californicus* Group were not observed to wander on the ground at night even though large populations of the species were found adjacent to a suitable road near Mt. Shasta City, California. Many

diurnal species (the terms nocturnal and diurnal are used throughout this paper in reference to mating time) wander at night and are actively feeding and ovipositing at this time. Desert or arid land species utilize the "cover" of night to venture from bushes or concealment into the open where they would desiccate or be eaten during the day.

As indicated in earlier studies (Rentz and Birchim, 1968), collection of young nymphs early in the spring at a specific locality yields higher number of katydids than can be gathered later in the tedious manner described above. This is attributed to continuous mortality factors during the life cycle. Such laboratory-reared katydids can be used for various studies. They are easily raised, segregated in pint jars with the aluminum screening placed around the inside periphery. A glass tube with moist cotton and dry dog food is all that is needed for proper nourishment.

Preservation. — Useful museum specimens demand more than mere killing and pinning. Without evisceration a pinned specimen loses much of its taxonomic value. Colors are lost, soft structures are obscured or rot and internal organs are unavailable for future study. I have found two techniques of value in preserving decticines. After evisceration the internal cavity should be dusted with a small quantity of powder, (consisting of 3/4 talcum and 1/4 boric acid) as described by Rentz and Birchim (1968). The specimen is then loosely stuffed with cotton and pinned. The viscera can be retained for future examination, appropriately labelled and stored in 70% ethyl alcohol.

Specimens in liquid preservative are of value in investigation of internal structures and certain external features which may be distorted by drying. The mere preservation of a katydid in 70% alcohol had nearly as many disadvantages as the old technique of pinning un-eviscerated specimens. Specimens so preserved become stiff and brittle, color and color pattern are usually lost, and in most instances, the alcohol is so diluted by the body fluids its preservative capabilities are diminished unless soon changed. I prefer a method of liquid preservation described by Williams (1968) which is as follows: the specimen is killed in hot water below the boiling point (90°C). This is necessary to preserve the specimen in a useful position and increase the permeability of the cuticle for

fixative penetration. Care should be taken to remove the specimen immediately upon death to avoid "cooking" which discolors the muscles and cuticle. The specimen is then placed in a solution of 12 parts commercial strength formalin, 30 parts 99% isopropyl alcohol, 2 parts glacial acetic acid, and 56 parts distilled water. Injection through the body wall is necessary for proper penetration to all parts of the body. Larger specimens, *I. californicus, I. elegans,* should be left in the solution for up to 6 hours; small specimens, *I. apollo, I. callimerus,* may be left in the liquid up to 3 hours but should be examined during these periods to prevent the specimens from becoming too brittle. The specimen is then removed and stored in 70% ethyl alcohol. Museum specimens preserved in this way are, except for most green colors, life-like in color and form, and the legs are resilient, not breaking when manipulated. Additionally, the internal body contents are available for other studies.

Acknowledgements

I wish to express my sincerest appreciation to all who have aided me during the course of this investigation. I would first like to thank my thesis committee, Dr. W. W. Middlekauff (Chairman), Dr. P. D. Hurd, Jr. and Dr. H. G. Baker.

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Figures 1 to 14 and 54 to 111 were drawn by Mrs. Susan MacDonald. Figures 22 to 53 are the work of Mrs. Marjorie Smith. Donna Foster prepared the tables. The excellence of their endeavors is evident in the illustrations.

Throughout much of this period of study I was accompanied in the field by my associate the late James D. Birchim. He has played a prominent role in the collecting and observing of these

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Subfamilial Assignment and Position Within the Decticinae

The genus *Idiostatus* is unquestionably a member of the subfamily Decticinae, the free plantula, broad fastigium, and distal spines on the anterodorsal surface of the fore tibia being uniquely diagnostic characters shared by nearly all decticine katydids. In many other characteristics, such as the presence of a free ventral border on the pronotum, short metasternal lobes, and non-singing habit of the females, this genus may be considered as a typical member of the subfamily. Cohn (1965) and Rentz and Birchim (1968) previously characterized the subfamily noting relationships with the more tropical Listroscelinae, largely predaceous, predominantly greenish katydids. Nearctic members of this subfamily (*Neobarrettia-Rehnia*) were, for over 50 years, considered to be members of the Decticinae until removed by Rehn (1957), Cohn (1957, 1965). *Idiostatus* species show little in common with the Listroscelinae, either structurally or biologically.

Table 1 tabulates five primary characters as they appear on 13 genera considered here to be related in some measure to *Idiostatus*. Although I have been greatly aided by other Orthopterists throughout the world in obtaining representatives of these genera, I feel that I must see more species in each genus before the table can be further amplified. A revision of the subfamily at the generic level must be undertaken if meaningful deductions are to be made. Therefore, I am assuming that the genera in the table are valid generic units. *Antaxius, Rhacocleis* and *Idionotus* are not included in Table 1 since they only superficially resemble those above.

It can be inferred from Table 1 that the first five genera are probably the result of a single line of evolution. All are desert or arid land inhabitants suited for ground dwelling or utilization of low plant cover. *Pediodectes* and *Eremopedes* are very closely related

TABLE 1. — Five primary characters as they appear on 13 genera considered to be related in some measure to *Idiostatus*.

	I	II	III	IV	V
Pediodectes	+	C	2	L	G
Eremopedes	$+_{-}$	C	2	L	G
Inyodectes	−	C	2	L	G
Oreopedes	−	C	2	L	G
Ateloplus	−	C	2	S	G
Eulithoxenus	−	C_a	1	S	L
Uvarovina	−	C_a	2	S	L
Bienkoxenus	−	C_a	2	S	L
Bergiola	$-_s$	S	2	S	L
Ammoxenulus	−	T	2	S	L
Paradrymadusa	−	C_v	2	S	A
Steiroxys	−	T	2	L	A
Idiostatus	−	T, S	2	L, S	A

Column I — Presence (+) or absence (−) of prosternal spines, ($-_s$) minute spines.

Column II — Nature of ovipositor. Carinate laterad (C), serrated (S), tuberculate laterad (T), carinate and expanded dorsad (C_a), carinate and expanded ventrad (C_v).

Column III — Number of apical calcars on dorsal surface of hind tibia.

Column IV — Nature of the plantula. More than half as long as metatarsus (L), $\frac{1}{3}$-$\frac{1}{4}$ as long as metatarsus (S).

Column V — Length of ovipositor relative to length of hind femur. Half as long or less (L), greater than half but not as long (G), as long or longer than hind femur (A).

and may be found to be congeneric after an extensive study is completed. *Inyodectes* and *Oreopedes* are curious monotypic genera obviously derived from *Eremopedes*-like stock but not really closely related to other genera. *Ateloplus*, a rather large genus broadly distributed throughout the Sonoran Desert and its western margins, is also distinctly eremopedioid but different in that all species known possess an abbreviated lateral pronotal lobe.

The genera *Uvarovina, Bienkoxenus, Eulithoxenus* (Plates 5-6) are Asian arid land inhabitants. All share a peculiar development of the dorsum of the ovipositor and relatively short limbs. With the

exception of *Uvarovina,* species in these latter two genera illustrate one of the most peculiar modes of life yet seen in the Decticinae. Uvarov (1928) and Bey-Bienko (1951) reported that species in these genera occur under stones in the barren deserts of Mongolia. The species live where there is a minimum of vegetation, and observations made during the original collection of *Eulithoxenus* (then *Bergiola*) *mongolicus* Uvarov in 1926 by Kritchenko (Uvarov, 1928) indicate that the short legs of the species are used almost solely in crawling to safety in the rocky habitat (Plate 6). Jumping was kept to a minimum, the short legs and plantulae being unsuited for such behavior.

Bergiola (Plate 5) is a distinct, short limbed Asian genus with a peculiar combination of characters including a serrated, broadly tipped ovipositor, short limbs and plantula and minute prosternal spines. It is believed that species of this genus occupy a habitat similar to *Eulithoxenus* species. *Ammoxenulus* is a long-legged Asian genus superficially resembling *Idiostatus,* but due to having seen only males, I can draw conclusions on that sex, only on the basis of the original description of *A. pavlovskii* in Bey-Bienko (1951). His figures show a degree of similarity of the ovipositor of that species with many seen in *Idiostatus,* the tuberculation and smoothly acute apex being typical of the genus. The hind tarsi are elongate in *A. pavlovskii* as are the ventral distal calcars of the hind tibia. The innermost tarsal spur is fully as long as the proximal tarsal segment which itself is uniquely elongate. The genus *Paradrymadusa* of the Middle East very much resembles *Idiostatus* in general facies and the species before me, *P. sordida* Hermann, the type of the genus, from Armenia (Plate 5) resembles *I. californicus.* It differs chiefly from the latter in the presence of a single spine mesad on the anterior surface of the fore tibia, and the odd decurved, carinate apex of the ovipositor. This group was reviewed by Uvarov (1942) and likely represents convergent evolution toward an arid adapted morphotype. From all indications this group is also derived from more northern Palearctic stock and a number of derivatives have migrated south and given rise to a complex of genera and species now found in the Middle East and North Africa.

Reconstruction of Possible History of Idiostatus

In the absence of a fossil record, the abundance of decticine genera and species in Asia and Europe, Handlirsch (1925) listed 160 Palearctic species out of a known world total of 260; Zeuner (1941) included 103 species in *Metrioptera* and *Platycleis* alone, and the close relation of primitive Asian, European, and Middle Eastern representatives suggests a probably Asian origin for many if not all of the Nearctic genera. *Atlanticus,* with species in the eastern United States and Asia is illustrative of close ties of Asian-North American decticine fauna. Other orthopteroid groups show similar affinities, the most notable of which include the apterous montane grasshopper formerly in *Zubovskya* (now *Boonacris*) and the wood eating cockroach, *Cryptocercus*. both of which have species in North America and Asia.

The genus *Idiostatus* is most closely related to *Steiroxys,* a large genus with many undescribed species inhabiting mesic habitats of the Pacific Northwest. All known species of *Steiroxys* are diurnal and, with few exceptions, occur in more moist habitats than species of *Idiostatus.* However, several species of *Steiroxys* are known from the sagebrush areas of the northern Great Basin, usually near marshes or pond margins.

The progenitors of the *Steiroxys-Idiostatus* complex of species likely migrated over the Bering-Arc during the early Eocene, a phenomenon which is well documented with various mammalian groups of this epoch (Simpson, 1947). Conditions at that time indicate a somewhat subtropical climate capable of sustaining ancestors of the now tropical Listroscelinae and offering a workable hypotheses for the entrance of that katydid group into the American tropics (Cohn, 1965). Post Oligocene conditions led to a long cooling period with the permanent disappearance of the Bering Arc, a northwest flow of the warm Japan Current and a southward flow of the cooler arctic waters. This has resulted in increased aridity to the southern continental area. The record of mammalian migration between Asia and North America indicates that the climate of the Bering Straits has been cool to cold-temperate since the mid-Tertiary. From the Miocene to the present, virtually all of the animal migrants have been members of cold-climate groups (Cohn, 1965). The non-migrants have all been warm climate animals which were unsuccess-

ful in the transmigration even though they were all widespread and abundant in the tropics and subtropics. Prior to the Miocene, the climatic adaptations of the migrants are difficult to determine, but Simpson (1947) believes the distinction between migrants and non-migrants followed the same pattern as later.

Mid-Miocene uplifting of the major western north American mountains probably initiated differentiation of modern representatives of the groups. Chaney (1940) concluded that there was mountain uplifting in the Cascades at this time, a region where the *Steiroxys-Idiostatus* ancestors likely occurred during that period. The Sierra Nevada uplift was considerably later in the early *Pleistocene* (Axelrod and Ting, 1960) and the Peninsular Ranges of southern California and northern Baja California were uplifted during mid-Pleistocene (King, 1959). Cohn (1965) synthesized an interesting accumulation of evidence into a hypothetical history of dry environments in western North America. It is apparent from his data that conditions were much more humid and generally warmer in western North America during the Cenozoic than at present. Pliocene and Pleistocene ancestors of the *Steiroxys-Idiostatus* complex could have found the extensive forests of the Pacific Northwest favorable for their development, isolation occurring as conditions changed and the evolution of arid land ecotypes and morphotypes resulted.

The distributional limits of *Idiostatus* are of particular interest zoogeographically since they suggest arrival after the development of the Colorado-Green River system. In July 1967 two weeks were devoted to intensive collecting along these rivers. Road collecting in the Spring Mountains, north of Las Vegas, Nevada (figs. 16, 21) yielded considerable numbers of *I. aequalis,* especially along Lee Canyon road. This proves that the genus now exists near the northern part of the Colorado River. To the south of that river all collecting was negative. Highway 89, near Page, Arizona, was similarly examined at night but no *Idiostatus* katydids were found. Orthoptera have been well collected in Arizona due to their economic and biogeographic importance and there is not a single record for the genus in that state. The noted Orthopterist and decticine collector, E. R. Tinkham, was a resident of the state during his prime field-collecting years and never encountered a single representative of *Idiostatus* during that time. Considering the wide range of ecological conditions

DISTRIBUTION OF THE GENUS IDIOSTATUS

tolerated by *Idiostatus* one would expect to find some representatives today if they had ever occurred there.

TABLE 2. — Tabulation of ten characters of *Idiostatus* thought to reflect evolutionary sequence.

	I	II	III	IV	V	VI	VII	VIII	IX	X
californicus Group										
gurneyi	+	−	−	S	T	A	M	0	3, 4	D
wymorei	+	−	−	S	T	A	M	0	2	D
californicus	+	+	−	S	T	A	M	0	2	D
fuscus	−	+	−	S	T	A	M	0	2	D
hermannii Group										
variegatus	+	+	−	C	T	A	M	0	2	D
hermannii	+	+	−	C	T	A	M	0	2	D
inermoides	+	+	−	C	T	A	M	0	2	D
inermis Group										
rehni	−	+	−	C	T	A	M	0	2	D
inermis	−	+	−	S	T	A	M	0	2	D
major	−	+	−	S	T	A	M	0	2	D
elegans Group										
magnificus	−	+	−	S	Sm	Bc	M	0	2	D
elegans	−	+	−	S	Sm	Bc	M	0	2	D
bechteli	−	+	−	S	Sm	Bc	M	0	2	D
martinellii	−	+	−	S	Sm	Bc	M	0	2	D
aberrans Group										
aberrans	+	−	−	S	S	Br	P	0	2	?
viridis	+	−	−	?	S	?	?	0	2	?
inyo Group										
apollo	−	−	−	C	C	Bd	U	0	2	N
birchimi	−	−	−	C	C	Br	U	0	2	N
inyo	−	−	−	C	S	Ba	P	0	2	N
callimerus	−	+	−	C	S	Br	U	0	2	N
aequalis Group										
aequalis	−	−	+	C	S	Ba	P	2	3	N
middlekauffi	−	−	+	C	S	Br	U	2	3	N
kathleenae	−	−	+	C	S	Br	U	2	3	N
fuscopunctatus	−	−	−	C	C, S	O	P	0	2	N

Column I — Green color phases in 50% or more of a population (+), or less than 50% of population (−).

Column II — Coloration of lateral portion of distal abdominal tergites; marked with black (+), without markings (−).

Column III — Presence (+) or absence (−) of dark spot at apex of tegmen.

Column IV — Nature of male tegmen. Cells and veins similarly colored (S), cells and veins contrasting (C).

Column V — Nature of ovipositor. Tuberculate laterally (T), smooth with minute tubercles (Sm), carinae on lateral margins (C), serrated dorso-ventrally (S).

Column VI — Development of the titillator. Base little developed, arm flat (A); base absent but with basal callosities (Bc); base well developed, arm flat (Bd); base well developed, arm tubular, teeth reduced (Br), teeth absent (Ba); base well developed, arm minute (O).

Column VII — Nature of tenth abdominal tergite. Mesal area soft, membranous (M); mesal area undifferentiated (U); tergite produced laterally forming 2 prongs or acute projections (P).

Column VIII — Number of spines on anterior margin of dorsal surface of fore tibia.

Column IX — Number of spines on anterior margin of dorsal surface of middle tibia.

Column X — Time of courtship activity. Diurnal (D), nocturnal (N).

The sole intrusion of *Idiostatus* east of the Colorado-Green River system involves penetration east and south by *I. variegatus* in northeastern Utah and adjacent northwestern Colorado (fig. 16) at the headwaters of this river system. This population would appear to be physically restricted from penetration further south by the northeast arm of the Colorado River and isolated to the north and east by the Rocky Mountains.

The trend in *Idiostatus* appears to be evolution of arid land ecomorphotypes. The development of a nocturnal habit and thamnophily seem to be obvious moves in this direction. Allied with this is the development of a more attenuate body and a proportionately longer ovipositor, a trend which is repeated over and over in the arid land species. The intraspecific relationships of the genus are discussed in the following section.

Table 2 tabulates 10 characters believed to be of evolutionary significance among the 24 known species of *Idiostatus*. Although the sequence of columns listed in the table may not reflect any increasing amount of evolutionary importance, the characters have been

arranged within the columns to reflect probable evolutionary trends. For example, within Column V, regarding the nature of the ovipositor, an evolutionary sequence is indicated from a tuberculate condition to a smooth surfaced, carinate condition. Similarly in Column X a nocturnal mating habit is believed to be a derived behavioral characteristic.

It is apparent from the characters listed that *Idiostatus,* as I have defined it, is composed of species derived from at least 7 lines of evolution. These have been treated as species groups in the text of this paper. The *californicus* Group, which is considered to be the most primitive, consists of rather generalized, diurnal species found in montane environments. Populations of this group have a high percentage of green individuals with the exception of *I. fuscus* which is an aberrant species inhabiting more xeric condition than others of the group and not known in a green color phase. The *hermannii* Group consists of species derived from another evolutionary line. These species are of a similar variegated color pattern with a high percentage of green color forms. All are more xerophytic than *I. californicus,* although requiring plant cover such as greasewood for successful maturity. The 3 species in the *hermannii* Group are diurnal. The *inermis* Group, consisting also of 3 species, shows more adaptation to an arid land morphotype in that the color pattern is greyish or usually light brown. Green forms make up only a small percentage of any given population. The *elegans* Group also shows arid land adaptation in biology, morphology and population structure of its 4 species. Populations of this group emerge only during years of favorable rainfall and then remain highly localized. The ovipositor of the female seems especially suited for use in a sandy or loose soil habitat. The *aberrans* Group exemplifies an unusually strange offshoot involving an odd mixture of characters. These katydids are probably nocturnal and inhabit the Coniferous Woodland community, a unique intrusion for any member of this genus. The peculiar sternal tubercle, development of the subgenital plate of the female, as well as the most unusual color pattern, are characteristics not shared by any other member of the genus. The *inyo* Group is illustrative of greater degree of arid land adaptation. Members of this group are pale, light or straw-colored insects, attenuate in body form, and adapted for bush dwelling. Members of the *inyo* Group also show a nocturnal mating habit and

a carinate or serrate ovipositor. The *aequalis* Group, composed of 4 species, illustrates the ultimate achievement in the evolution to an arid-adapted morphotype. Species in this group are all pale or greyish, thamnophilous nocturnal insects. Males of *I. fuscopunctatus* and *I. aequalis* have the last abdominal tergite modified, and only in the latter species is used for stroking the abdomen of the female in courtship. Also of note is the presence of additional spines on the anterior dorsal surface of the fore and middle tibia among some members of this group.

The morphological and behavioral characteristics of each of the species groups are discussed in greater detail in the appropriate sections of the text. The sequence of species in this paper follows that listed in Table 2.

Biology

Eggs. — Some interesting biological features of *Idiostatus* are exhibited by the eggs of these insects. It is probable that the sporadic temporal occurrence of the katydids (as referred to repeatedly throughout this paper) is due in part to the diapausing ability of the eggs.

During the course of this study many attempts were made to induce hatching of fertile eggs with some interesting results. In 1968 groups of eggs of the following were subjected to varying conditions: *Idiostatus californicus, I. gurneyi, I. wymorei, I. hermannii, I. inermoides, I. inermis, I. apollo, I. inyo, I. aequalis, I. fuscopunctatus, Plagiostira gillettei, Zacycloptera atripennis, Steiroxys* sp., and *Idionotus siskiyou.* The eggs were assumed to be fertile since they were obtained from females collected as adults or females kept in community cages with other individuals of both sexes. The eggs were placed on sterile sand moistened with distilled water in small, covered petri dishes. After remaining at room temperature for one day, three temperature parameters were tested. One group of eggs was exposed at 32°F, another at 38°, and the third was kept at room temperature (between 68-72°). Each group was divided into 3 subgroups, the number of eggs in each dependent upon the total available at the time of the experiment. For instance, there were many more eggs of *I. hermannii* available than of *I. apollo,* the latter of which was represented by eggs from only 2 females. Each subgroup was subjected to the experimental temperatures for a period of 1, 2 or 3 months. Water

was added as needed. At the end of 3 months a small sample of eggs was dissected. No development was detected in any. The remainder were continued under the respective temperature regimes for an additional 9 months, then removed and allowed to remain at room temperature for another month. At the end of this period all eggs were dissected and no development was found.

In 1969 a group of eggs was taken from a community "egg pool" in a cage of *I. magnificus* from near Smoky Canyon, Nevada, in the original soil in which they were laid, and placed outdoors on 10 October. They were allowed full exposure to winter conditions in Berkeley, California. It must be noted that the conditions in Berkeley are quite different from those of the native habitat where snow and prolonged periods of cold weather are not uncommon. By 12 April 1970 none of the two dozen eggs dissected showed any development. My colleague, Dr. Rudiger Hartmann, took some of the same group of eggs, prior to exposure to winter conditions, and subjected them to varying temperature, light and humidity regimes. He was able to induce development in *I. magnificus* eggs from near Smoky Canyon, Nevada, by exposing them to moisture for several days at room temperature, placing them in xylene for four to five minutes, 100% ethyl alcohol for four to five minutes and then permitting them to sit submerged in water for five days. Eyes, appendages and body shape were apparent in the developing embryos but they never hatched. Experiments are now being designed to isolate the factors which induced development in this test and to try to relate them to the environmental factors influencing natural hatching. He also treated groups to different chemicals such as 100% ethyl alcohol and then exposed them to varying environmental conditions.

In 1970 the same group of eggs of *I. magnificus* was placed on the roof of the Academy of Natural Sciences of Philadelphia on 18 October for exposure to the eastern winter. They were returned to the laboratory on 10 March 1971. Hatching began on 31 March of that year and resulted in an emergence of nearly two dozen individuals all of which matured and agreed in every way with normal field collected examples of the species.

A group of the eggs laid by the individuals which hatched in 1971 plus the unhatched eggs of the 1969 batch were again placed on the roof of the Academy on 10 October 1971 to undergo exposure to the

winter conditions. These eggs were returned to the laboratory on 23 March 1972. None hatched from the 1971 batch but a single female emerged from the eggs laid in 1969.

From these rather crude experiments it appears that *Idiostatus martinellii* requires at least a one-year diapause before any development occurs in the egg stage. There is also evidence that eggs of a given batch hatch over a period of several years rather than all at once. This is apparently also true for certain desert moths, J. Powell (personal communication). Experiments are continuing in order to determine whether the above holds true for other species of *Idiostatus* especially those not living in desert habitats.

Most species of *Idiostatus* inhabit xeric regions, either mountain tops or deserts, and oviposit directly into the soil to a depth of an inch or more, this determined by the length of the ovipositor (Plate 4). For an egg to remain viable for a year or more under extreme conditions of the habitat, special adaptations must exist. Hartley (1964) reviewed the structure of the eggs of British Tettigoniidae, discussing the porous surface of the eggs and the double layered chorion (the inner and outer chorions). In his key to the species based on eggs, decticine katydids (at least British species) may be characterized by the following: possession of an outer chorion formed at least from a series of pillars with a meshwork layer present dividing the outer chorion into distinct cells which are partially roofed giving the surface of the egg a smooth overall appearance; the presence of 4-12 micropyles on the ventral surface of the egg about 1/5 of its length from the posterior end with each micropyle consisting of a narrow tube, replacing the normal structure of the chorion and widening at the outer end entering the chorion normally to the surface; the micropyles were found to be occluded in the laid egg. The eggs of *Idiostatus* agree well with this characterization. The micropyles, with ordinary light microscopy, are readily discernible as small granulations because of the occluded entrance of each micropyle. Eggs of several species of *Idiostatus* were sent to Dr. Hinton for examination with the scanning electron microscope. Plate 2 shows some of his results. Samples of the following species of *Idiostatus* were examined: *I. gurneyi, I. wymorei, I. apollo, I. hermannii, I. inermoides, I. inyo, I. aequalis* and *I. fuscopunctatus.* In addition, other representatives of the Decticinae were sent and similarly studied by him: *Idionotus siskiyou,*

Plagiostira gillettei, Zacycloptera atripennis, Steiroxys sp., *Neduba convexa,* and *Neduba* sp. All eggs were laid by females in the laboratory. With the exception of the samples from the 2 *Neduba* species, all of the eggs fit the general morphotype (Plate 2). *Neduba* species are rather exceptional among the Nearctic shield-backed katydids in that they probably oviposit in decaying wood. Scanning electron microscopic studies of the eggs reveal a poorly developed plastron in this genus. The term plastron has been used in the past to denote a gill or other respiratory apparatus that consists of a gas film of constant volume and an extensive water-air interface. Such films are held by hydrofuge structures which resist wetting by the hydrostatic pressures to which they are subjected in nature. The indication by Hinton (1969) suggests that instances of plastron respiration among terrestrial eggs greatly outnumber those of plastron respiration in all life-stages of aquatic insects.

Hinton (1959) showed, for the first time, the presence of plastron among terrestrial insects. He later expanded the studies (1960a, b, c; 1969) to reveal that such a structure is widespread among a great many non-aquatic insects as well as reviewing the various respiratory systems in insect eggs. In 1961 he defined the plastron's function as enabling "an egg to extract oxygen from the ambient water and therefore to continue its development during the period when it is flooded." Insects ovipositing in sheltered situations, protected from flooding (perhaps *Neduba* species), or on leaves or twigs where drainage is not a problem, were found to lack such a structure. Insects with eggs with a tough, impermeable chorion, such as some Staphylinidae, were also found not to have a plastron. Some aquatic insects lack an egg respiratory system but the eggs are embedded in a jelly-like substance, particularly when habitats are subject to sudden drying. This jelly is hygroscopic, and often proteinaceous. When subjected to desiccation, the jelly loses water slowly so that if the drying period is not too long, the egg is protected (Hinton, 1969).

Plastrons function in respiration by resisting wetting from the pressures exerted by raindrops falling upon them. This has been determined by direct observation by Hinton (1960a) in 2 fly species. The chorion meshwork (Plate 2C) holds a layer of gas, and aeropyles are also present which extend through much of the shell and affect the continuity of the chorionic gas layer and the ambient atmosphere.

The interstices between the meshwork pattern hold the gas. Hinton (1969) notes that in the Phasmidae the egg may become filled with gas while within the oviduct or the spaces may dry out and fill with air after the egg is laid as in the Acrididae. It is not known which method is utilized by *Idiostatus.*

Hinton (1961, 1969) has defined 2 types of egg plastrons: those which consist of an enlargement of the aeropyles, or an increase in their number, or both; and those that consist of a network, as in Muscidae. The eggs of *Idiostatus* fit well in the later category as the aeropyles appear to be formed in the centers of poorly defined hexagonal areas that mark the boundaries of the individual follicular cells (Plate 2A-C). Hinton's figure 14 (Hinton, 1969) of a single crater of *Musca vetustissima* is remarkably similar to that of a single crater of *I. inermoides* (Plate 2C).

The eggs of *Idiostatus* are subjected, under natural conditions, to periods of intense rain (late summer, early spring) and periods of high evaporation (early summer, late winter). The plastron would seem ideally suited to cope with such severity of moisture extremes. Perhaps changes in the nature of the plastron, such as its decomposition or reduction in its ability to function effectively, act to induce hatching of the eggs. Examination of the egg at several time intervals prior to hatching would be needed to determine this. Of interest is the fact that when eggs are left at room temperature, in vials without sand or moisture, within 6 months they dehydrate and shrivel. When moistened, they regain their original shape and the contents appear "normal." It is not known if these eggs are still viable. Furthermore it is not known whether eggs shrivel under natural conditions.

Nymphs. — Eggs hatch in spring and the nymphs may be found abundantly on or near the ground in weedy plant growth. It is not known whether nymphs of all species (such as those of the *hermannii* Group) are thamnophilous but juveniles of the *aequalis* Group which are thamnophilous as adults appear not to be since they were found on the ground or in weeds near Running Springs, San Bernardino County, California. During a given year, populations of a species may not be synchronized with regard to uniform development of nymphs. It also appears that the eclosion of eggs is dependent on local weather conditions and, as a result, a population at a higher elevation may be a few weeks to a month less advanced in its development as the same

species at a lower elevation. Nymphs undergo at least 5 and possibly as many as 7 instars prior to maturation (7 being known in *Anabrus simplex*). It is difficult to determine the exact number even with caged individuals due to the habit of the young katydids of consuming the cast skin immediately upon molting.

Populations of nymphs remain together during development but gradually become spaced farther and farther apart. Plant materials form the greater portion of the diet of the immatures as indicated by crop and stomach analysis. Thus, few or no insect parts were found in gut contents of nymphs of *I. aequalis* collected near Running Springs, California. Maturation is completed from early to mid summer depending upon the species and local conditions. Although nymphs may be found late in the summer in high altitude localities, no species is known to overwinter in that stage.

Adults. — Adults of the genus *Idiostatus* seem to be rigorously dependent upon local weather conditions in some species and rather well adapted to a wider variety of conditions in others. Adults of *I. kathleenae* and *I. middlekauffi* appear in late June or early July thus avoiding hot weather and usually not surviving much beyond late July. In contrast to this short period of adult life, such species as *I. inermis* may be found as adults from early July to mid October at the same locality.

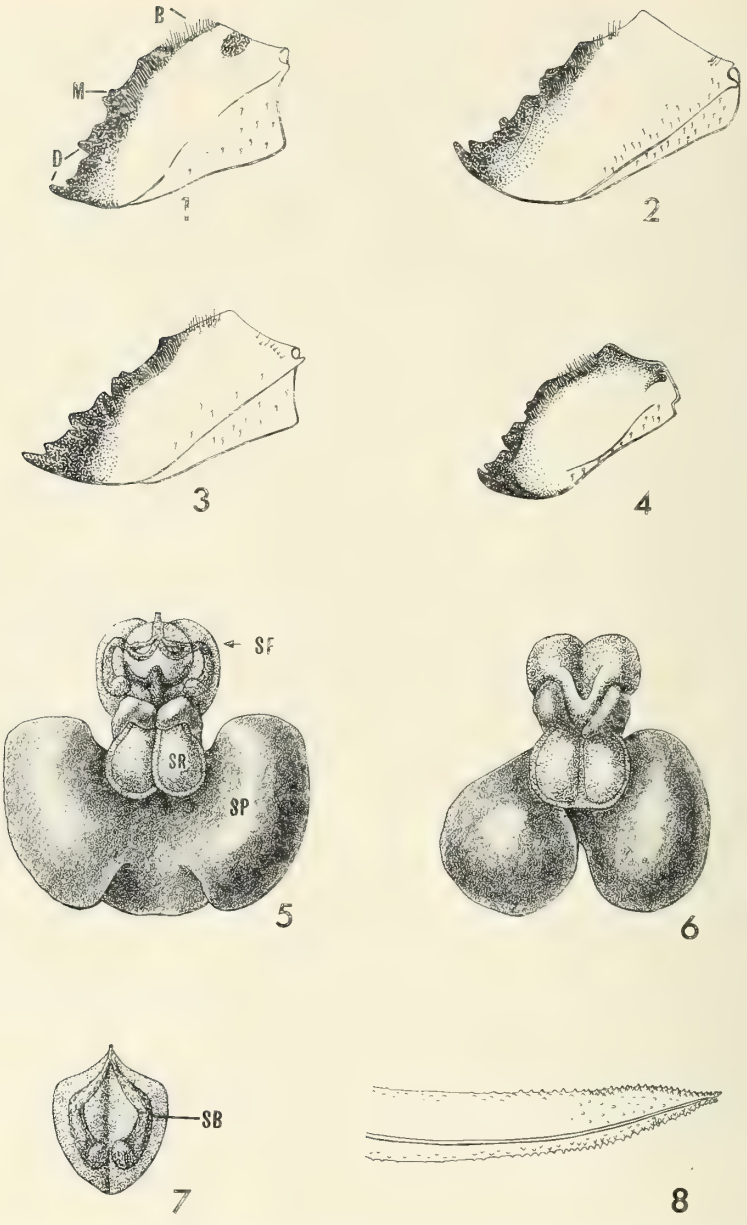
Adults of certain species (*I. californicus, I. inermis, I. elegans, I. bechteli*) congregate and entire populations have been detected moving together across the landscape. Individuals of most species, however, appear to be rather rare although they are often localized. Species of the *californicus, hermannii, elegans* and *inermis* Groups are mostly ground dwelling, venturing into shrubbery and low bushes infrequently while the species in the *inyo* and *aequalis* Groups are thamnophilous. The habits of the 2 species of the *aberrans* Group are poorly known, the only specimens collected by the author were found on a small fir tree.

Idiostatus contains both diurnal and nocturnal species. Diurnal species are characteristic of high elevations, although not restricted to these habitats. Species in the *californicus, hermannii, inermis* and *elegans* Group are diurnal while those of the *inyo* and *aequalis* Groups are nocturnal. Nocturnal mating is regarded as an adaptation to an arid environment and a derived characteristic.

Females of all species thus far investigated oviposit at night, usually prior to midnight. This is accomplished merely by insertion of the ovipositor into the soil. Several eggs may be deposited singly at one ovipositional site. The female may insert her ovipositor into the ground several times until a suitable site is found. Then one or more eggs are laid, these accompanied by pronounced abdominal pulsations. At completion of this act, the female withdraws her ovipositor and scrapes the top of the hole and covers the spot completely. Only the ovipositor is used in this activity.

Diet. — Decticine food habits are at best poorly known. Even such an economically important pest as the Mormon cricket, about which much has been written, has only recently been intensively studied with regard to its food preferences. Gangwere (1967) carefully studied the feeding behavior of *Atlanticus testaceus* (Scudder), an eastern species inhabiting woodland grass ecotone. He found both in field and laboratory studies that the species is carnivorous by preference but an omnivore by necessity. The choice of food plants was wide, including especially the flowers of forbs and less often their leaves, the fruits of certain woody plants and occasionally their leaves, and the flowers of grasses. Animal matter ingested included mostly small insects such as aphids, leafhoppers and some bugs which the katydids encountered in their habitat. The investigation by Ueckert and Hansen (1970) of the foods of the Mormon cricket, *Anabrus simplex,* showed different preferences from those of *Atlanticus testaceus.* They discovered that this species, in northern Colorado, was highly herbivorous, forbs constituting over 50% of the diet. Arthropods and fungi contributed an average of approximately 20% and 16% of the diet respectively. Some seasonal change in composition of the diet was noted but the variation was not believed by them to be as significant as previously thought by range managers. Arthropods and fungi were found to be common major foods of the Mormon cricket, comprising as much as 37% and 23% of the diet, respectively, at certain times. There was even an indication that the crickets selected plant parts infested by fungi for the increased carbohydrate and protein content.

Species of *Idiostatus* appear to be omnivorous much as described for *Atlanticus testaceus,* but the varied habitats occupied by the species probably indicate a wide variety of food habits. The gut contents of several species of *Idiostatus* have been examined. The feeding activi-



FIGS. 1-4. — Right mandibles of *Idiostatus* species. 1. *I. elegans,* Rocky Cyn., Nev., D-dentes, M-molar, B-brustia. 2. *I. californicus,* Plaskett Mdws., Calif. 3. *I. hermannii,* Rocky Cyn., Nev. 4. *I. inyo,* 6 mi. W. Independence, Calif. FIGS. 5-8. — Spermatophores of *Idiostatus* species. 5. *I. magnificus,* nr. Smoky Cyn., Nev., SF-sperm flask, SR-sperm reservoir, SP-spermatophylax. 6. *I. hermannii,* Rocky Cyn., Nev. 7. Sperm flask, *I. magnificus,* same data as above. 8. Ovipositor, *I. gurneyi,* paratopotype.

ties of some individuals in the field have been noted. The results of these studies may be found in the appropriate sections of this paper. The mandibles of 4 distantly related species of *Idiostatus* are illustrated in figures 1-4. They are basically similar to the Carnivorous-Forbivorous subtype of the Forbivorous class of mandibles described by Gangwere (1965). The mandible is elongate and hook-like. The incisor molar (M) and dentes (D) are well defined and sharp, the latter surrounding a distinct molar concavity.

Natural Enemies

The robust size and nomadic tendencies of many species of *Idiostatus* would seem to render these insects easy prey for birds, lizards and other vertebrate predators. However, no direct observations of such predation have been made during the period of this investigation.

Only a single instance of parasitism has been noted among the hundreds of individuals reared or otherwise maintained alive. A last instar female *I. aequalis* collected near Smart's Ranch, on forest road 3NO3, San Bernardino County, California, on 29 June 1968 was parasitized by maggots of a sarcophagid fly. On 2 July 1968 3 maggots emerged from the katydid and formed puparia. Flies emerged from 2 of the puparia on July 19 and 20 were determined as *Blaesoxipha* sp. by H. J. Reinhard through the courtesy of P. H. Arnaud, Jr. The katydid died within 3 hours of their emergence.

The capture of *Idiostatus* katydids as prey by wasps and robber flies is probably rather widespread but only a single incident of such activity is known. An adult male *I. inermis* was collected at Dorris, California, on 31 July 1969 as prey of *Sphex ichneumoneus* (Linnaeus). Bohart and Menke (1963) listed several other American tettigoniids utilized as prey by this wasp and a single decticine, *Atlanticus dorsalis* (Burmeister) was among them. La Rivers (1945) studied the predation of the wasp *Palmodes laeviventris* (Cresson) on the Mormon cricket. It provides its burrows with 2 to 4 crickets which are paralyzed by the sting. That such predation can have an effect on a given population is evidenced by the data accumulated by La Rivers. He estimated 30,000 wasps were working an area which measured one mile by a half mile with 256,504 burrows supplied with over 5,000,000 crickets.

The slopes above Soldier Meadows, Nevada, were heavily populated by *Idiostatus bechteli* in early July 1969. Many individuals of

the large species *Palmodes laeviventris* were also seen either flying through the area or feeding on *Eriogonum* flowers. No Mormon crickets, a reported host, were found at this locality. *I. bechteli* is very similar in size to *A. simplex* although it is grey in color while the latter is dark brown. It is probable that species of *Idiostatus* would be suitable prey for this wasp but no direct observations were made.

Larval mites of the families Trombidiidae and Erythraeidae were found on adults of both sexes of *I. elegans* collected at Rocky Canyon, Nevada, 1969. The red mites were found most abundantly under the pronotum or under the tegmina with fewer numbers found attached at the bases of the legs. Adults of these mites are free-living. The larvae presumably are not host specific.

Economic Aspects

From time to time species of *Idiostatus* have been of economic concern in western rangelands. During years of high population numbers, they have been said to cause damage to forage crops. The Cooperative Economic Insect Survey Report of the U.S. Department of Agriculture has noted the abundance of *I. inermis* (see discussion, *I. inermis* for details) on range in the western Great Basin on many occasions during the summer months. The abundance of *I. bechteli* and *I. elegans* on rangeland during outbreak years of the late 1950's (see discussion under both species) prompted control measures. Poison bran was broadcast over the localized area of infestation and control was readily achieved. *I. californicus* was reported in large numbers in northern California on grasslands by G. M. Buxton (personal communication, see discussion of *I. californicus*) and the entire population seemed to be moving downhill as a group.

Perhaps the large size of the katydids and the localized nature of many populations tend to incriminate *Idiostatus* as damagers of range forage when there is no damage or it is not responsible. My observations indicate that the species noted above provide examples of population eruptions during certain outbreak years. In each instance where large numbers were abundant, other less obvious Orthoptera (many of them well documented rangeland pests such as *Aulocara elliotti, Ageneotettix deorum* and *Oedaleonotus enigma*) were also abundant. Recent studies of the food habits of other decticines such as *Atlanticus testaceus* (Gangwere, 1967) and the Mormon cricket (Ueckert and

Hansen, 1970) suggest that decticines are rather specific in their food habits and are not indiscriminate plant feeders.

Behavior

Idiostatus consists of species which mate during the day (usually in the morning) as well as those which mate at night (usually prior to midnight). No species has been found which mate both day and night. Diurnal mating is perhaps an adaptation to avoid cold night temperatures in those species living at higher elevations (*I. fuscus, I. inermis, I. gurneyi, I. wymorei*) since ambient temperature is usually too low for activity. However, species found in some warmer areas (Great Basin and mountain foothills) also mate during the day. But advantages here seem to involve species isolating mechanisms and not low temperatures, Rentz (1972). Nocturnal courtship is almost exclusively confined to arid land species or their derivatives in areas where temperatures after dark are usually high enough to permit activity well into the night (*I. aequalis, I. inyo, I. birchimi*).

Stridulatory activity is closely associated, although not exclusively, with mating. Mating is often preceded by a period of calling activity. Males sing; females are silent and, if sexually receptive, respond by moving to the singing male. Each species possesses a repertoire of at least three different calls. The Calling Song is the call most frequently heard by collectors. It is a prolonged buzz often augmented and sung in unison when there are several males in a single bush. Males performing the Calling Song usually sit in a prominent position, if in a bush, then high in it, if on the ground then on a projecting rock or other landmark. The head is bent downward, the pronotum tilted exposing the tegmina completely. The song is made by rubbing the tegmina together over a file-scraper mechanism typical of katydids and crickets. The tegmina often move so swiftly as to appear motionless. Calling males usually do not wander but maintain a stationary position of prominence. Groups of singing males may be encountered during years of peak abundance. Presumably this acts as a focussing point for females and guarantees more matings than if individuals were more scattered throughout the habitat.

Another song commonly heard in most of the species seems to have several functions. It is a short simple sound consisting of short "zics," which may have a warning function. When a collector approaches and disturbs an individual in the midst of his Calling Song,

it immediately changes to short "zics" until the disturbance ceases. Short "zics" may be heard at night from certain day mating species, perhaps an aggregating function to help keep the population together.

The third distinct call is made by some diurnal species of *Idiostatus* and is a Distress Call consisting of very loud "zics" emitted only when handled or otherwise greatly disturbed. The Distress Call has not been heard among nocturnal species even when they are handled. Upon hearing the Distress Call, other individuals in close proximity stop singing and often drop to lower branches or to the ground in an obvious effort to escape.

Katydids of the genus *Idiostatus,* like most other tettigoniids, do not perform their Calling Songs at random but have definite periods of calling and courtship activity. Males of *I. gurneyi,* for example, were unresponsive to females during afternoon hours but courted and mated in the morning. This correlates well with the observed acoustical activity patterns in nature. Nocturnal species commence calling usually within thirty minutes of sundown, often prior to complete darkness, and continue for approximately two hours. No decticine with which I am familiar sings continually through the night. Temperature often controls the singing periods; as the temperature drops, the Calling Song is less frequently emitted until the lower threshold is met. On the other hand, in desert environments where evenings are usually warm and supposedly suitable for such continued singing activity, singing also ceases prior to midnight. In the laboratory under controlled temperature conditions, individuals were found to behave in the manner observed in the field.

The moon also affects the singing periods of nocturnal species. Frequently no decticines of any species can be heard on clear nights when there is a full moon. A cloud cover on such a night reduces the light intensity and singing may occur. Short periods of high light intensity, such as observation in the field by means of a flashlight or gasoline lantern seem to have little effect on a singing male. This is apparently a threshold response involving time rather than intensity.

The Calling Song is species distinct and can be recorded and analyzed electronically. As taxonomists turn more toward the biological attributes of species in classification, the use of calling songs has become widespread. Because katydids sing at higher frequencies than crickets (100 kilocycles for some katydids, Dumortier, 1963; 10-16

kilocycles in many crickets), more sophisticated equipment is needed than for the latter species for which a normal tape recorder is usually sufficient.

The stridulatory file is the only link the museum taxonomist has with the stridulatory activity of the species. This structure is readily available in dead specimens and of considerable taxonomic value in some groups. Ragge (1969), Emsley, Nickle and Moss (1967) and most recently Huxley (1970) have shown the significance of this structure in taxonomy. I have utilized the length and number of lamellae in this investigation, but the gross appearance is also of considerable value, especially at the species group level. Ragge (1969) and Huxley (1970) presented a method of making nitrocellulose replicas of the stridulatory file for use in measurement, illustration and study. The distance between the lamellae can be of significance and the scanning electron microscope can be of particular value in making measurements.

The linear distance between the first and last lamella being determined as "file length." "Number of lamellae" includes all countable lamellae, however minute. This may be misleading since many of the smaller lamellae, and possibly some of the larger ones as well, do not take part in the song. But since there is no method to determine just which lamellae are involved, it is thought best to use total number. This probably accounts for the considerable degree of individual variation in lamella number among files of similar length within a given population. Both lamella number and density appear to be useful.

The mating behavior of *Idiostatus* species has been described (Rentz, 1972) with reference to its significance in species isolation.

Taxonomy

Genus IDIOSTATUS Pictet

Idiostatus Pictet, 1888, p. 63.
Cacopteris Scudder, 1894, p. 178.

Type of the genus: *Idiostatus californicus* Pictet, 1888, by monotypy.

Characterization. — *Idiostatus* combines the following characteristics, some shared with other decticine genera but never in this combination: basic color pattern green, gray, brown, or tan (distinctive within each of the species groups); prosternum unarmed; pronotum with humeral angles bent, subcarinate, not parallel or continuous through anterior one-fourth of disk; median carina of pronotum weak or absent, never continuous through anterior one-fourth of disk;

tegmina of female lobate, never lanceolate or attingent; hind tibia quadrate, lateral surface of nearly equal width for entire length; plantula of hind tarsus never more than half the length of metatarsus; abdomen of male with central portion soft or sclerotized and laterally extended into acute, digitiform structures; subgenital plate of female with lobes short, usually blunt, broadly rounded; seventh abdominal sternite of female with or without median tubercle; ovipositor more than half as long as hind femur, frequently longer, straight or upcurved, apex smooth, serrate, tuberculate or carinate.

Generic description. — HEAD robust, one and one-half to one and three-fourths times longer than median width; eye round to dorsoventrally elongate, moderately to slightly protruding; fastigium of vertex broad (laterally compressed in species of the *aberrans* Group), one and one-half to two times broader than first antennal segment, distinctly projecting above first antennal segment; base of fastigium sulcate anteriorly. Frons and genae smooth with widely scattered pits and sparsely pilose. THORAX. Pronotum (see above figures) with anterior three-quarters smooth, rounded to lateral lobes; humeral angles of distal one-quarter of disk bent, suggestive of carinae, but never distinctly carinate; anterior portion of disk (*I. gurneyi*) with humeral angle subcarinate, never continuous to anterior one-quarter; surface of disk smooth (*elegans* Group) or polished (*I. fuscus*); anterior one-quarter to one-eighth of disk with shallow, undulant, transverse sulcus, obsolete in median portion; median portion of disk with (*elegans* Group) or without (*inyo* and *aequalis* Groups) poorly developed V-shaped medial incision; lateral lobes well indicated, humeral sinus weak to well indicated. Prosternum unarmed, often with smooth transverse ridge; meso- and metasternum each with a pair of acute projections directed caudad. LEGS. Fore leg shorter than middle leg, coxa with acuminate spine directed cephalad; fore tibia subcylindrical, swollen in auditory area, auditory foramen slit-like, outer margin broadly obtuse; anterior margin of dorsal surface of fore tibia unarmed (single exception; *I. fuscopunctatus*), posterior margin with three widely spaced spines, the distal spine subapical in position; ventral surface of both fore and middle tibiae with six spines on anterior and posterior margins; middle tibia armed on anterior margin of dorsal surface with two to three spines, posterior margin with three to four spines; hind tibia well spined above on both margins, apex with two spurs; ventral surface with fewer spines on inner and outer margins, apex with four spurs. Hind tarsus with distinct plantula, variously modified, never more than half the length of metatarsus. TEGMINA. Sexually dimorphic; in males lobate, rounded, venation as in figs. 9-14; stridulatory file varying in length, curvature and number of lamellae as in table 3-6; female tegmina elongate with up to six continuous longitudinal veins, never lanceolate or attingent. MALE TERMINALIA. Last abdominal tergite specifically modified mesad, pilose, soft or sparsely tuberculate (*californicus, elegans, hermannii, inermis* Groups, figs. 22-39); last abdominal tergite without soft region as above, but uniformly smooth, the distal apices often elongate, paired appendages (*aberrans, inyo, aequalis* Groups, figs. 40-53). Cercus specifically distinct. Titillators well de-

veloped, arm reduced only in *I. fuscopunctatus* (fig. 83); arm flattened, serrated on outer margin, base poorly or moderately developed (*californicus, hermannii, inermis* Groups, figs. 54-66); arm tubular, smooth, tuberculate (*inyo, aequalis* Groups, figs. 72-84); arm flattened, base well developed, often fused (*I. apollo,* fig. 71); base poorly developed, arm serrated, membrane at base with callosities (*elegans* Group, figs. 68, 69). Subgenital plate scoop-shaped, medial impression weakly or well indicated; styles as small pegs or elongate structures. FEMALE TERMINALIA. Last abdominal tergite incised, the outer margins smooth or acutely produced. Cercus cylindrical, without internal tooth, subgenital plate simple, lateral lobes variously developed (*californicus, hermannii, inermis, inyo, aequalis* Groups, figs. 88-95, 100-109) or the basal pockets well indicated, sclerotized (*elegans* Group, figs. 95-99), subgenital plate tongue-like, internal margins produced, seventh abdominal sternite with a distinct tubercle (*aberrans* Group, figs. 110-111); subdefined (*I. inyo,* fig. 103). Ovipositor shorter, as long as, or longer than hind femur, straight weakly or strongly curved; apex tuberculate (*californicus, hermannii, inermis* Groups), smooth, without carinae or with low tuberculations (*elegans* Group), without tuberculae, serrated, often weakly so on dorsal and ventral margins, laterally carinate (*inyo, aequalis, aberrans* Groups). COLORATION. Green phases common (*californicus, hermannii, inermis* and *aberrans* Groups, Plates 6-9); grey predominant (*inermis, elegans* Groups, Plates 7, 8); brown phases common, often with lighter longitudinal striping (*inyo* and *aequalis* Groups, Plates 9, 10). Tegmina of males concolorous reddish brown or straw brown or with veins contrasting or with apical black spot (*aequalis* Group, Plates 9, 10).

Key to Adult Males of Idiostatus [1]

1. Last abdominal tergite (tergite ten) with well sclerotized dorsal projections (figs. 40, 43, 44, 47, 49-51) 20
   Last abdominal tergite without such projections, the mesal region often membranous, lateral lobes rounded, soft (figs. 23-39, 41, 42, 45, 46, 52, 53) 2
2 (1). Tegmen with dark subapical spot 3
   Tegmen without subapical spot, although cells may be darkened, contrasting with veins 4
3 (2). Tegminal spot poorly indicated, usually brownish, occupying apex of tegmen. Cercus (fig. 52) elongate. Titillator (fig. 82) with arm elongate. Coloration light pale brown, greyish forms infrequent. Known from sand dune areas near Antioch, California (fig. 21) ..... *middlekauffi* new species
   Tegminal spot heavily indicated (fig. 11), black, occupying almost entire apical region of tegmen. Cercus (fig. 53) more robust than above. Titillator (fig. 84) with arm attenuate. Coloration predominantly dark grey, small percentage of lighter individuals en-

[1] Male of *I. viridis* unknown.

countered. Known from Pinnacles National Monument, California (fig. 21) ..... *kathleenae* new species

4 (2). Mesal region of last abdominal tergite without conspicuous soft region, lacking pilosity 5

Mesal region of last abdominal tergite distinctly differentiated from lateral portions of segment, soft, membranous, densely to sparsely pilose 6

5 (4). Cells of tegmen jet black. Cercus (fig. 41) slender, elongate, somewhat dorso-ventrally flattened. Titillator (fig. 71) with arm only slightly longer than base, apical half serrate on outer margin. A small pale brown species (Plate 7) known from northwestern and central Nevada and adjacent California (fig. 20) ..... *apollo* new species

Cells of tegmen brown. Cercus (fig. 42) stout, extremely flattened dorso-ventrally. Titillator (fig. 72) with arm much longer than base, apical half weakly serrate. A moderate sized, pale brown species (Plate 7) known from the Owens Valley, California (fig. 20) ..... *birchimi* new species

6 (4). Cells and veins of tegmen concolorous (Plate 7) 7

Cells and veins conspicuously contrasting in color (Plates 6-8) 11

7 (6). Coloration predominantly green, sometimes brown. Pronotum usually concolorous, often highly polished. Cercus (figs. 22-24) with inner tooth on same plane as main shaft, little developed; apex unmodified 8

Coloration reddish brown or grey, usually with white flecks laterally on dorsum of abdomen; green forms present in very small percentage of population. Pronotum often bicolored. Cercus (figs. 33, 34) with inner tooth highly developed, spike-like 19

8 (7). Cercus (fig. 23) dorso-ventrally flattened, broad throughout entire length; inner tooth short, sharp. Titillator (fig. 546) dorso-ventrally flattened, base poorly developed. Coloration in two phases, green more commonly encountered. Known from the mountains and foothills surrounding the northern portion of the Central Valley of California (fig. 15) ..... *californicus* Pictet

Without above combination of characters; cercus not as shown, more cylindrical, not as dorso-ventrally flattened 9

9 (8). Tegmen protruding little beyond apex of pronotum (Plate 7). Known from north central California and southern Oregon (fig. 15) .... *gurneyi* new species

Tegmen protruding beyond apex of pronotum for a distance of one-half or more the pronotal length 10

10 (9). Abdominal tergite 8 marked with black (fig. 24). Cercus dorso-ventrally swollen, inner tooth stout. Titillator (fig. 57). Pronotum highly polished; outer pagina of hind femur mostly black above horizontal midline. Known from high elevations near the crest of the central Sierra Nevada Mountains, California (fig. 15) .... *fuscus* Caudell

Abdominal tergite 8 not marked with black (fig. 22). Cercus (fig. 22) elongate, inner tooth not greatly developed. Titillator (figs. 55, 56) dimorphic, arm either long or short, bowed, apex serrated, spatulate. Known from the central Sierra Nevada Mountains of California west of the crest (fig. 15) ..... *wymorei* Caudell

11 (6). Portion of tegmen anterior to stridulatory file black, remainder reddish brown (fig. 13). Cercus (figs. 45, 46) stout, with widely separated teeth both on same plane. Titillator (fig. 78) with base well developed, arm tubular, weakly serrate distad. A small species (Plate 10) greyish in color; outer pagina of hind femur with or without irregular black markings. Known from the central and southern Sierra Nevada Mountains near or at tree line, east of the crest (fig. 20) ..... *callimerus* Rehn and Hebard

Without above combination of characters 12

12(11). Veins of tegmen light brown or cream-colored, highly contrasting with darker color of cells. Sides of pronotum and abdomen darker than dorsum; dorsum reddish, straw brown, yellow or light green, often bounded by longitudinal stripes (Plate 6) 13

Veins of tegmen dark brown or reddish brown. Color of insect not as described above, usually grey or dark brown 15

13(12). Cercus (fig. 29) with two teeth directed inward, these usually in same vertical plane, the lower tooth more elongate, spine-like. Known from north central Nevada (fig. 16) ..... *inermoides* new species

Cercus with single tooth directed inward, if two teeth directed inward then one tooth is elongation of outer toe of cercus (figs. 58-61) 14

14(13). Cercus (figs. 59, 60) with inner tooth extremely elongate, acuminate, nearly as long as main shaft of cercus (northern and central populations) or inner tooth shorter, outer toe of cercus prolonged (fig. 61) (southern populations). Known from central portions of Great Basin (fig. 16) ..... *hermannii* (Thomas)

Cercus with inner tooth small, stout (fig. 58), much less than one-fourth length of main shaft. Known from northern fringes of the Great Basin (fig. 16) ..... *variegatus* Caudell

15(12). Cercus bifurcate, two distinct teeth directed inward (figs. 38, 39) 16

Cercus with single tooth directed inward (figs. 30, 31, 35, 36, 38) 17

16(15). Apical tooth of cercus (fig. 39) usually twice as long as subapical tooth. Color in life uniform grey becoming brownish after death (Plate 8). Abdomen without longitudinal striping. Known from northeastern California and adjacent Nevada (fig. 18) .... *martinellii* new species

Apical tooth only half again as long as subapical tooth (fig. 38). Coloration most frequently grey with or without broad brownish dorsal longitudinal stripe (Plate 8); greenish forms present. Known from northwestern Nevada (fig. 18) ..... *bechteli* new species

17(15). Cercus (fig. 37) with distal two-thirds extremely swollen; inner tooth short, emanating dorsad in proximal one-third of main shaft. Abdo-

men uniform grey, without longitudinal striping; green forms unknown. Largest species in genus. Known from west central Nevada (fig. 18) ..... *elegans* Caudell

Without above combination of characters 18

18(17). Cercus (figs. 35, 36) bulbous in distal one-fourth; inner tooth placed in apical one-third of main shaft. Titillator (fig. 67) usually with basal callosities. Abdomen (fig. 116A-C) uniformly greyish becoming greyish brown in death. Pronotum uniform or mottled grey, never zonally bicolored. Known from northeastern California and adjacent Nevada (fig. 18) ..... *magnificus* Hebard

Cercus (figs. 30, 31) dorso-ventrally flattened, inner tooth placed mesad. Titillator (fig. 63) always without basal callosities. Abdomen usually greyish with white flecks dorsad; green forms commonly encountered. Pronotum normally bicolored, distal one-quarter reddish brown, anterior three-quarters darker brown. Known from north central California and adjacent southern Oregon (fig. 17) ..... *rehni* Caudell

19 (7). Inner tooth of cercus (fig. 34) emanating from base, undulant, elongate. Titillator (fig. 66). Known from eastern California (fig. 17) ..... *major* Caudell

Inner tooth of cercus (fig. 33) placed in distal two-thirds of shaft, stout, short. Titillator (figs. 64, 65) geographically variable; north central California population with arm bowed, spatulate, other populations with arm elongate, apex sharp, acute; western Great Basin (fig. 17) ..... *inermis* Scudder

20 (1). Tegmen with conspicuous dark subapical spot (fig. 21; plates 9, 10) 21

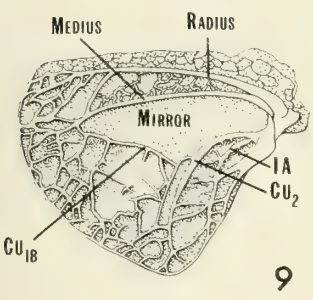
Tegmen uniform in coloration, without subapical spot 22

21(20). Dorsal projections of last abdominal tergite (tergite 10) very elongate, prong-like (figs. 48-51). Cercus attenuate, inner tooth greatly prolonged distad; southern and central California and Nevada (fig. 21) ..... *aequalis* Scudder

Dorsal projections of last abdominal tergite short, deltoid (fig. 47). Cercus short, stout, inner tooth not as above; mountains of southern California (fig. 21) ..... *fuscopunctatus* Scudder

22(20). Dorsal projections of last abdominal tergite acute, sharp (fig. 40). Cercus attenuate. Tegmen light straw brown; overall coloration greenish with two yellow longitudinal stripes dorsally (fig. 116I); mountains of central and northern California (fig. 19) .... *aberrans* new species

Dorsal projections of last abdominal tergite rounded, obtuse (figs. 43, 44). Cercus with apex rounded, varying geographically. Tegmen reddish brown; overall coloration greyish or brownish; Owens Valley and adjacent areas of eastern California (fig. 20) .... *inyo* Rehn and Hebard



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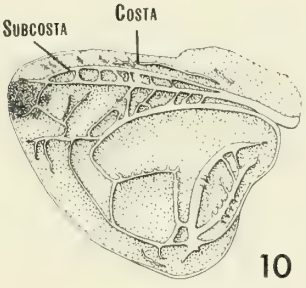

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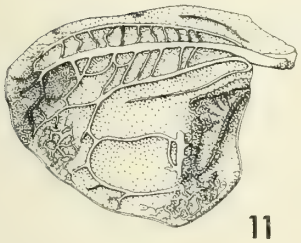

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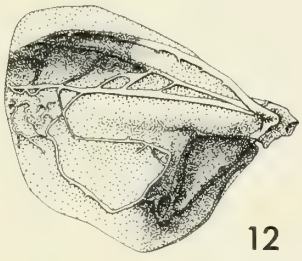

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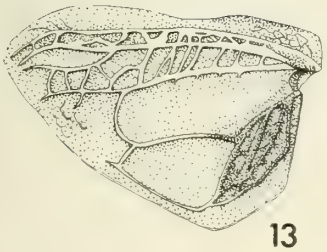

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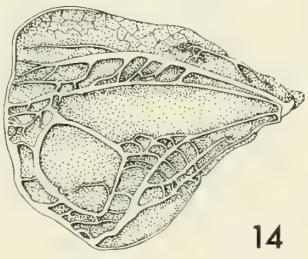


14

FIGS. 9-14. — Left tegmen of *Idiostatus* species. 9. *I. californicus,* Gazelle, Calif., Comstock-Needham nomenclature. 10. *I. middlekauffi,* paratopotype. 11. *I. kathleenae,* paratopotype. 12. *I. aequalis,* topotype. 13. *I. callimerus,* Sage Flat Camp, Calif. 14. *I. bechteli,* paratopotype.

Key to Adult Females of Idiostatus

1. Mesal portion of seventh abdominal sternite smooth, without tubercle 2
   Mesal portion of seventh abdominal sternite with tubercle (figs. 110, 111), either weakly indicated or prominently developed 23
2 (1). Distal margin of each abdominal tergite whitish giving abdomen a distinctly ringed appearance 3
   Distal margin of abdominal tergites unicolorous with rest of tergite, if not, then band not continuous on sides of abdomen 12
3 (2). Abdominal tergites 8, 9, 10 intensely marked with black, especially laterad; dorsum of abdomen usually uniformly greyish in life; tegmen reddish brown; tibia and ventral surfaces of femora aquamarine in life becoming greyish in poorly preserved specimens (Plates 3, 6, 7). Usually large greyish species somewhat colonial in habit, often localized 4
   Without above combination of characters 7
4 (3). Cercus with apex differentiated, narrowed, acuminate, darker brown .. 5
   Cercus with apex undifferentiated, usually blunt, concolorous with main shaft 6
5 (4). Apex of cercus sharp, acuminate, distinctly directed ventrad; arm attenuate, elongate for half or more its length. Subgenital plate as illustrated (fig. 99). Tegmen with 4 longitudinal veins. Known from northeastern California and adjacent Nevada (fig. 18) .... *martinellii* new species
   Apex of cercus sharp, distinctly directed laterad; arm stout basad, narrowed only in apical one-quarter. Subgenital plate as illustrated (fig. 98). Tegmen with number of veins variable. Known from northwestern Nevada (fig. 18) ..... *bechteli* new species
6 (4). Cercus with apical one-third narrowed, attenuate, weakly directed outward. Subgenital plate as illustrated (fig. 97). Tegmen with five prominent longitudinal veins. Known from west central Nevada (fig. 18) ..... *elegans* Caudell
   Cercus evenly tapered from base to apex, stout, usually straight. Subgenital plate as illustrated (fig. 96). Tegmen with two prominent longitudinal veins. Known from northeastern California and adjacent Nevada (fig. 18) ..... *magnificus* Hebard
7 (3). Distal portion of each abdominal tergite with white margin expanded basally in lateral portion of tergite in line with humeral angle of pronotum, these expansions forming an indistinct longitudinal stripe, one on each side of abdomen (Plates 4, 6, 7). Colors varying from yellow browns to greens, reds, black, never dark brown. Tegmen with veins light straw brown, cells darker. Ovipositor shorter than hind femur, straight to weakly upcurved. Occupants of the Greasewood-Saltbush plant community 8
   Distal portion of abdominal tergites not expanded as above (Plates

2, 7). Colors usually dark brown or grey, green forming only a small percentage of each population. Tegmen with veins and cells reddish brown. Ovipositor longer than hind femur, usually straight. Occupants of the Montane Chaparral or Sagebrush plant community 10

8 (7). Cercus stout, short, only apical one-sixth narrowed. Known from central portion of Great Basin (fig. 16) ..... *hermannii* (Thomas)

Cercus slender, attenuate, apical one-third or more distinctly narrowed, straight or directed ventrad. Known from Great Basin 9

9 (8). Cercus with apical one-fifth distinctly directed ventrad. Subgenital plate as illustrated (fig. 92). Known from north central Nevada (fig. 16) ..... *inermoides* new species

Cercus straight, apex not directed ventrad. Subgenital plate as illustrated (fig. 90). Known from the northern fringes of the Great Basin (fig. 16) ..... *variegatus* Caudell

10 (7). Size small (Table 8), form robust. Cercus attenuate, apex straight. Subgenital plate as illustrated (fig. 94). Inhabitant of xeric situations. Known from many localities in the western Great Basin (fig. 17) ..... *inermis* (Scudder) (in part)

Without above combination of characters 11

11(10). Cercus stout, extreme apex directed inward. Subgenital plate as illustrated (fig. 95). Known from eastern California (fig. 17) .... *major* Caudell

Cercus elongate, straight. Subgenital plate as illustrated (fig. 93). Known from Siskiyou County, California, and adjacent southern Oregon (fig. 17) ..... *rehni* Caudell

12 (2). Dorsal surface of fore tibia armed with single spine on inner margin 13

Dorsal surface of fore tibia unarmed on inner margin 15

13(12). Cercus densely pilose, stout in basal two-thirds, abruptly narrowed to apex (southern California populations) or cylindrical not tapered (Nevada populations). Subgenital plate as illustrated (figs. 105, 106). Portion of thorax adjacent to lateral margin of tegmen usually blackish. Ovipositor-femur ratio (Table 8). Known from many localities in southern and central California and Nevada (fig. 21) ..... *aequalis* (Scudder)

Without above combination of characters 14

14(13). General coloration light straw brown. Cercus tapered, apical one-third feebly directed ventrad. Subgenital plate as illustrated (fig. 107). Known from sand dune areas near Antioch, California (fig. 21) ..... *middlekauffi* new species

General coloration dark grey, a small percentage of specimens from a population brownish. Cercus tapered, distal one-half very attenuate, straight. Subgenital plate as illustrated (fig. 108). Known

from Pinnacles National Monument, California (fig. 21) .... *kathleenae* new species

15(12). Apex of ovipositor with low, undulant serrations on upper and lower margins (cutting edge); lateral surface of valves without tuberculations, carinate at apex 16

Apex of ovipositor with tuberculations on upper and lower edges; lateral surface usually densely tuberculate, without carinae 19

16(15). General overall coloration pale yellowish or straw brown 17

General overall coloration darker brown or greyish 18

17(16). Small species (Table 8). Subgenital plate as illustrated (figs. 100, 101). Inhabitant of Greasewood-Saltbush plant community. Known from northwestern and central Nevada and adjacent California (fig. 21) ..... *apollo* new species

Larger species (Table 8). Subgenital plate as illustrated (fig. 102). Inhabitant of the Juniper-Pinyon Woodland plant community. Known from the Owens Valley, California (fig. 20) .... *birchimi* new species

18(16). Ovipositor short (Table 8). Subgenital plate as illustrated (fig. 109). Known from the mountains of southern California (fig. 21) .... *fuscopunctatus* (Scudder)

Ovipositor long (Table 8). Tegmen with veins and cells light brown, cells never black. Cercus attenuate, evenly tapered to apex. Subgenital plate as illustrated (fig. 104). Known from the central and southern Sierra Nevada Mountains near or at tree line, east of the crest (fig. 20) ..... *callimerus* Rehn and Hebard

19(15). Entire surface of outer pagina of hind femur contrastingly dark brown dorsad of midline. Known from high elevations near the crest of the Sierra Nevada Mountains, California (fig. 15) .... *fuscus* Caudell

Outer pagina of hind femur either concolorous or with a few black spots, especially at base 20

20(19). General coloration greyish brown with two indistinct, longitudinal stripes on dorsum of abdomen formed by coalescence of white flecks. Inhabitant of the Sagebrush or Chaparral plant communities. Known from many localities in the western Great Basin (fig. 17) ..... *inermis* (Scudder) (in part)

Without above combination of characters 21

21(20). Size large (Table 8). Cercus very stout, apex blunt. Known from the mountains surrounding the northern portion of the Central Valley of California and adjacent foothills (fig. 15) .. *californicus* Pictet

Size smaller (Table 8). Cercus attenuate 22

22(21). Cercus very attenuate, five times longer than basal width. Subgenital plate as illustrated (fig. 86). Known from north central California and southern Oregon (fig. 15) ..... *gurneyi* new species

Cercus more robust, less than four times longer than basal width. Subgenital plate as illustrated (fig. 87). Known from the central

Sierra Nevada Mountains of California west of the crest (fig. 15) ..... *wymorei* Caudell

23 (1). Median tubercle of seventh sternite well developed (fig. 110). Occupant of the Coniferous Belt of the mountains of central and northern California (fig. 19) ..... *aberrans* new species

Median tubercle low, not as above 24

24(23). Overall coloration green; dorsum of abdomen with two bright yellow, longitudinal stripes; venter lavender. Subgenital plate as illustrated (fig. 111). Occupant of the Coniferous Belt of mountains of southern California (fig. 19) ..... *viridis* new species

Overall coloration greyish or brownish, without yellow dorsal stripes, coloration never green. Subgenital plate as illustrated (fig. 103). Occupant of the Pinyon-Sagebrush plant community of the Owens Valley and adjacent areas of eastern California (fig. 20) .... *inyo* Rehn and Hebard

The *californicus* Group

The four known species of the *californicus* Group (*gurneyi, wymorei, californicus, fuscus*) are moderate to large-sized katydids, diurnal in mating habits and often present in groups or "colonies." The nominal *I. californicus* is the largest species of the group and is the only thamnophilous representative; the others, with the possible exception *I. fuscus,* spend most of their time on the ground or in short herbaceous vegetation. Species in this group resemble many of those in the genus *Steiroxys* which often occur in similar ecological situations. Species in this group are montane in their distribution and inhabit subalpine clearings, mountain meadows, or chaparral situations where one might also expect to find representatives of the genus *Steiroxys.*

Morphologically, the group is distinct in possessing a usually unicolorous polished pronotum, and a polished appearance to the surface of the abdomen. The tegmen is also distinctive in being usually unicolorous reddish brown, the veins not contrasting with the cells in color. This group also possesses black ringing of the distal abdominal tergites, a feature often better indicated laterally than dorsally on abdominal terga seven and eight where it is obsolete. The short fore femur and the well-developed base of the titillator are also distinctive. Characteristics shared by the *californicus* Group and other groups include; the soft, pilose integumental area of the dorsum of tergum ten in the male, flattened condition of the arm of the titillator, and the nearly straight ovipositor. Two adult color forms are known for

each species of this group with the exception *I. fuscus* which is known solely in a brown phase. The other species occur in both brown and green color phases, these usually present in equal numbers, although there is evidence indicating edaphic control over this condition (see discussion, *I. californicus*).

All species in the *californicus* Group mate by day, *I. gurneyi* and *I. wymorei* not responding sexually after midday. *I. californicus* is the only known member which is acoustically active at night. Males emit short "zics" or "zips" after sunset until 10:00 PM (PDST). The calling song is never heard at night but the "zics," likely aggregative in function, are heard frequently during the day.

The species of the *californicus* Group range from Valley Grassland (*I. californicus*) to subalpine situations (*I. fuscus, I. gurneyi*) (fig. 15). The populations, with exception of *I. fuscus,* are usually large and distinctly localized.

Idiostatus gurneyi new species (Figs. 8, 15, 53a, 54, 86, Plate 7)

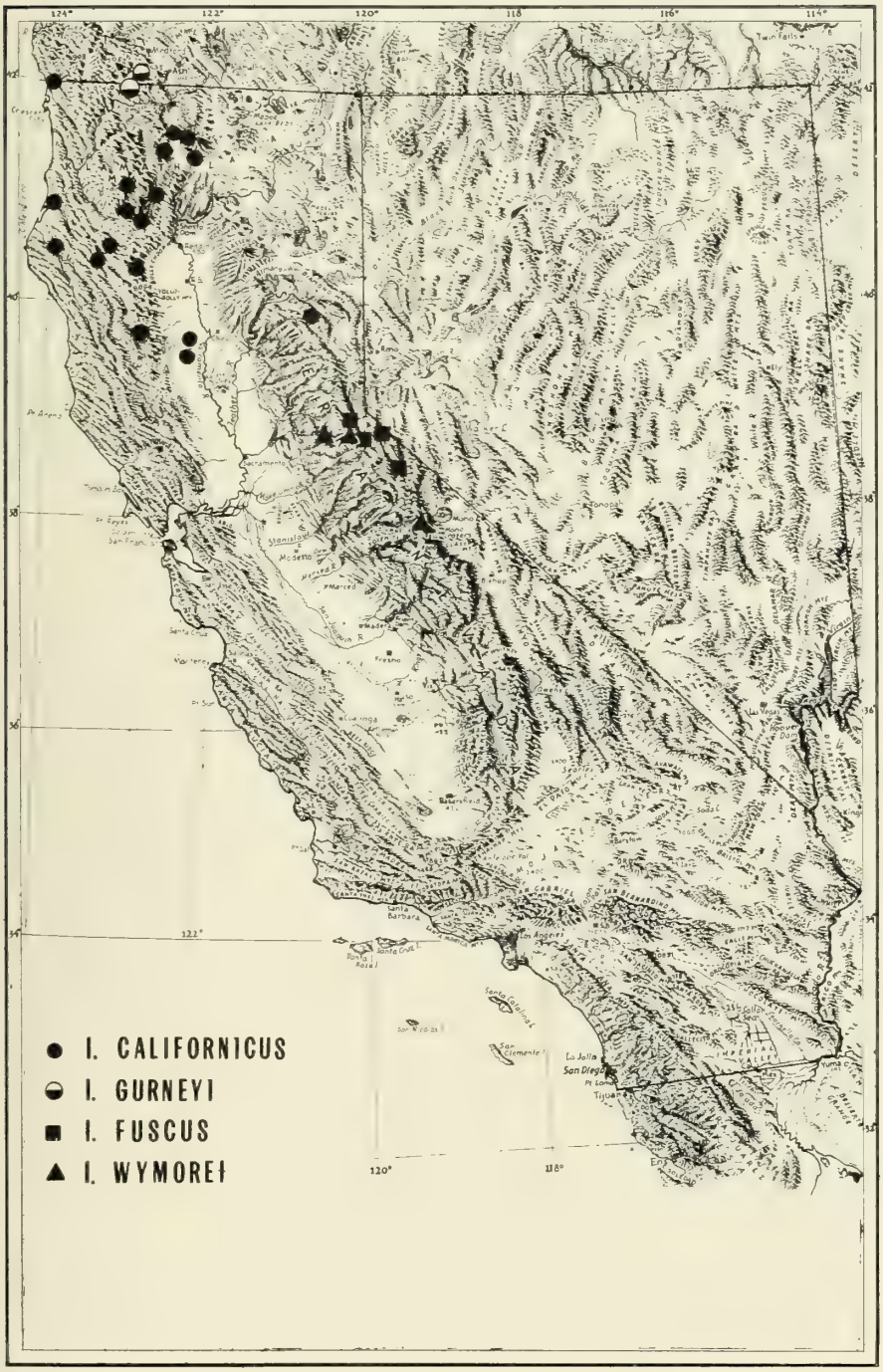
Type data. — One label, printed. "Oregon, Jackson County, Mt. Ashland Ski Bowl, 1 mi. W., Picnic area, 6,500 feet elevation, 6 September 1968, D. C. & K. A. Rentz."

Type locality. — The type locality is on the southwest slope of Mt. Ashland, a few hundred yards below the summit.

Deposition of primary types. — The holotype and allotype are deposited in the California Academy of Sciences, NO. 10,485.

Diagnosis. — *I. gurneyi* is a robust, ground-dwelling, montane species present in two distinct color forms usually in equal proportions. Coloration uniform phaneropterine or darker green or brown, the latter phase often with a lighter brown dorsal longitudinal stripe; no sexual dichromatism known. Males are distinctive in the following characters: median pronotal carina present, moderately developed; fore tibia one-half dorsal length of pronotum; outer pagina of hind femur with or without stripe; all femora without teeth on ventral surface; genicular margin of fore femur with single tooth on anterior margin, middle femur with single tooth on both margins, hind femur without teeth; plantula two and one-half times longer than basal width, apex acute, one-third length of metatarsus; tegmen protruding less than one-half dorsal length of pronotum; abdomen with weak indication of median carina; tergite ten little modified, densely pilose, medial area not differently colored; cercus (fig. 54) dorso-

FIG. 15. — Known distribution of the *californicus* Group.


124°
122°
120°
118
116°
114°
42
40
38
36
34
122°
120°
118°
● I. CALIFORNICUS
◒ I. GURNEYI
■ I. FUSCUS
▲ I. WYMOREI

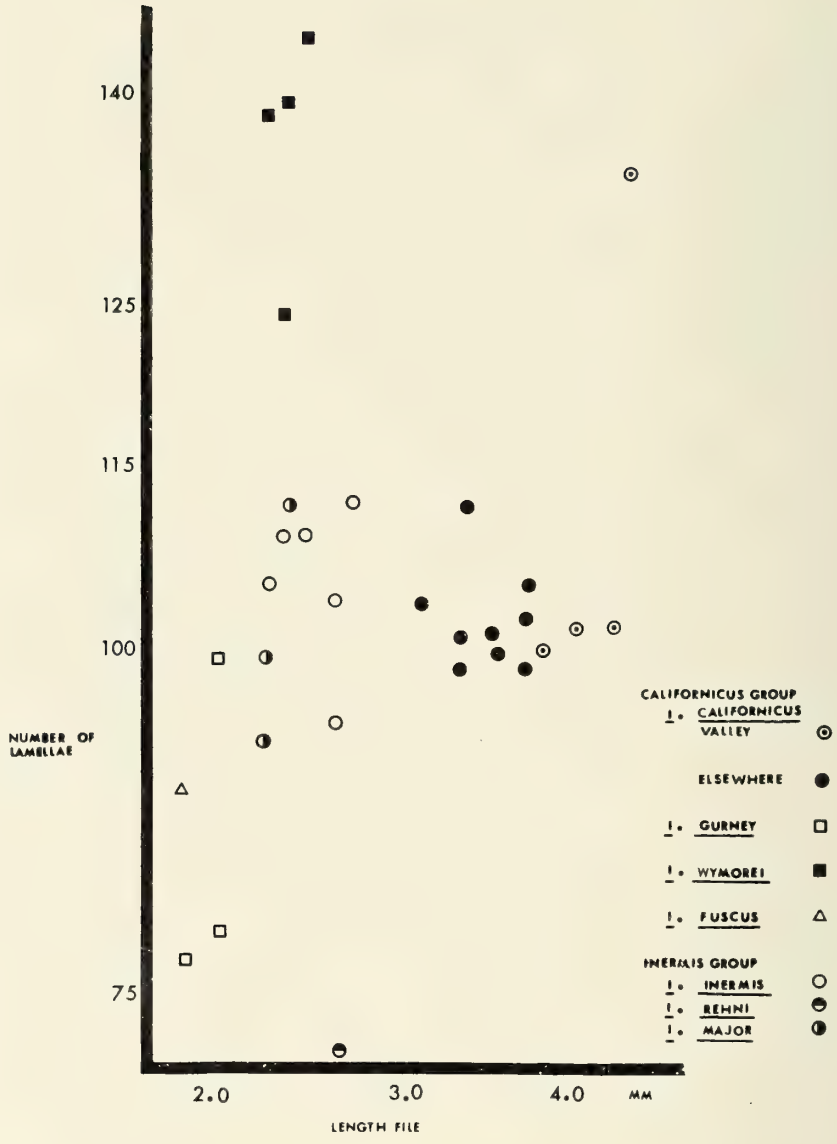


TABLE 3. — Scatter diagram of lamella number plotted against file length for left male stridulatory file.

ventrally flattened, inner tooth developed, directed cephalad; titillator with base rather well developed, arms parallel (fig. 54), serrated along entire length. Females may be identified by the following characteristics: tergite ten not incised, apex truncate; cercus attenuate, conical, six times longer than basal width, straight to slightly directed inward at apex; ovipositor nearly straight, as long or slightly longer than hind femur, apex serrulated. *I. gurneyi* is known from montane peaks from northern California and southern Oregon (Map 2) where it may be found on exposed slopes on the ground among low herbaceous vegetation.

Description. — HOLOTYPE MALE. Form robust. HEAD moderately amplected into the pronotum. Eye slightly bulging, somewhat cordate, directed anteriorad, less than twice as broad as first antennal segment. First antennal segment two and one-half times broader than second, one and one-half times longer. Antenna as long as body. PRONOTUM smooth dorsally, concave in posterior one-quarter; median carina moderately developed, in relation to the condition in species of *Steiroxys;* posterior margin of lateral lobe declivous, ventral margin convex; anterior one-eighth and posterior one-half of humeral angle bent, suggestive of lateral carinae but never raised, distinct or continuous as in species of *Steiroxys;* dorsum of disk with shallow undulant transverse sulcus weakly indicated on anterior one-eighth. TEGMINA slightly protruding beyond pronotum, less than one-half the dorsal pronotal length. APPENDAGES. Legs short. Fore femur one-half dorsal length of pronotum. Hind femur protruding slightly beyond apex of abdomen, less than one-eighth length of hind femur. Hind tibia with 21-23 dorsal spines on outer margin, 16 on inner margin, proximal spines very widely spaced, short; ventral surface with 12 spines on outer margin, 8 on inner margin. All femora without ventral teeth. Genicular lobe of anterior margin of fore femur with minute tooth; middle femur with minute genicular tooth on anterior and posterior margins; hind femur unarmed. Plantula of hind tarsus two and one-half times longer than basal width, apex acute, one-third length of metatarsus. Proximal tarsal segment twice as long as second segment; distal segment as long as proximal two combined. ABDOMEN with median carina weakly indicated, dorsal surface glabrous or sparsely pilose; tergite ten more densely pilose; dorsum of tergum ten with ill-defined membranous mesal area; lateral lobes formed by membranous area broadly rounded or not at all indicated. Cercus (fig. 53a), pilose. Subgenital plate, median excavation relatively shallow, incised less than one-fifth length of plate; styles, as long as one side of medial incision. Styles and external portion of subgenital plate densely pilose. Titillator as in fig. 54. COLORATION. Uniform phaneropterine green but eyes black, antennae reddish brown with exception of first segment which is green with black dorsal spot; second segment black with median green area dorsally. Humeral angle of pronotum brown; ventral portion of lateral lobe whitish yellow. Tegmina dorsally brown, margins reddish; veins not contrastingly colored. Apices and dorso-median portion of all spines dark brown. Outer pagina of hind femur almost unicolorous. Entire venter light green.

Holotype measurements. — Length: body, 21.20; pronotum, 5.80 × 3.70; fore femur, 3.80; tibia, 4.30; middle femur, 5.00; tibia, 5.60; hind femur, 15.30; tibia, 13.60; exposed tegmen, 2.70.

ALLOTYPE FEMALE. Similar to male with following exceptions: size slightly larger; tegmen protruding from beneath pronotum for a distance of less than one-eighth its dorsal length. Tergite ten with posterior margin truncate. Cercus attenuate, conical, six times longer than basal width, straight to slightly directed inward apically; apex unmodified. Subgenital plate as in fig. 86. Ovipositor nearly straight, apex distinctly serrulate; lateral tuberculations generally lacking. Coloration of brown phase. Ovipositor dark brown with darker serrations. Cercus brown, apex slightly darker.

Allotype measurements. — Body length, 24.50. Pronotum, 5.90 × 3.70; fore femur, 4.00; tibia, 4.80; middle femur, 5.30; tibia, 6.00; hind femur, 16.20; tibia, 14.40; exposed tegmen, 1.40; ovipositor, 17.20.

Variation. — The fore tibiae occasionally have a single spine on the anterior margin of the dorsal surface, usually found only on one leg. The number of spines on the middle tibia varies from 2-5 on each margin with a single specimen showing as much variation. The apex of the male cercus varies slightly in shape.

The most apparent variation is that of color, roughly 50% green, the others brown. The length of the ovipositor is subequal to or slightly longer than the hind femur. A single specimen from Condrey Peak, California, has the ovipositor distinctly shorter than the hind femur.

EGGS. — Eggs were obtained from captive females from the type locality. The preferred ovipositional site seems to be moist soil which is apparently different from that of many other species in the genus which oviposit in dry soil. Eggs were laid in moist soil in the laboratory when a choice was presented. When forced to oviposit in dry soil, the eggs always shriveled and apparently died. The color of the eggs matched well with number 79 (light grey yellow brown) on the ISCC-NBS color chart. Seven females laid 39, 54, 60, 69, 77, 90, and 107 eggs respectively between 9 September and 22 September 1968. Several unmated ♀♀ also laid eggs regardless of whether they had mated. Egg measurements (Table 9).

Derivation of name. — Named in honor of Dr. Ashley B. Gurney, U.S. Department of Agriculture, who has greatly helped me for many years. It was through the encouragement and untiring tutoring of Dr. Gurney that I decided to make a career studying Orthoptera.

Seasonal occurrence. — Adults have been obtained from 26 July (male, type locality) to 10 September (males, females, Condrey Peak). A fourth instar female was taken 22 July and a last instar male on 1 September from the type locality.

Song. — Males of *I. gurneyi* sing with a very low buzzing call (Plate 1B) audible for only a few feet. Males call most frequently

during the later morning hours during warm, sunny weather.

Distribution. — *I. gurneyi* is known from north central California and adjacent southern Oregon (fig. 15).

Records. — CALIFORNIA: SISKIYOU COUNTY: Condrey Peak, 10 September 1968 (G. M. Buxton, A. B. Gurney, 5 ♂♂, 10 ♀♀, USNM). OREGON: KLAMATH COUNTY: Crater Lake, 14 September 1923 (L. P. Rockwood, 1 ♂, USNM). Scott, 26 August 1928 (J. Rehn, M. Hebard, 1 ♂, 2 ♀♀, ANSP). JACKSON COUNTY: Mt. Ashland, 2 September 1964 (K. Goeden, 1 ♂, ex: alpine meadow, ODA); 26 July 1966, 6,500-7,100 ft. elev. (P. Opler, J. Powell, 1 ♂, 1 last instar ♀, 1 penultimate ♀, CIS); Picnic area, 1 mi. W. Ski Bowl, 6 September 1968, 6,500 ft. elev. (D. C. & K. A. Rentz, 16 ♂♂, 19 ♀♀, including holotype and allotype, CAS, DCR); 1 September 1968, summit 7,500 ft. elev. (L. G. Gentner, K. Goeden, A. Gurney, 1 ♂, 1 last instar ♂, 3 ♀♀, USNM); 5 mi. below summit, 1 September 1968 (G. Gentner, K. Goeden, A. Gurney, 6 ♂♂, 15 ♀♀, USNM).

Specimens studied. — 85, including holotype and allotype.

Hosts. — Individuals of this ground inhabiting species were commonly found hiding in dead and drying cornlily, *Veratrum* sp. A clump or pile of such plants yielded up to a dozen katydids. Other hosts include *Lupinus* sp. and a mint (Salvaceae).

Discussion. — *I. gurneyi* is a diurnal species occupying an interesting position both systematically and geographically. It shares many characters with species of the genus *Steiroxys* rendering generic placement somewhat difficult for the uninitiated. The humeral angles of the pronotum approach carinae more than in any other species of *Idiostatus;* pronounced carinae are typical of *Steiroxys* species. The small degree of protrusion of the tegmina beyond the apex of the pronotum is also suggestive of *Steiroxys.* The small plantula, lack of continuous pronotal carinae, coarsely serrate ovipositor (fig. 8) and generalized condition of the fingers of the subgenital plate of the female (compare figs. 85, 86) show relationship to *Idiostatus.* Ecologically, *I. gurneyi* is more typical of *Idiostatus* than members of *Steiroxys,* which usually occur in moist, heavily vegetated situations. Geographically, *I. gurneyi* occupies the northern limit of *Idiostatus* and the southern limits of *Steiroxys.* On the basis of the characters of Table 2, *I. gurneyi* appears to be the most primitive species of the genus.

Several matings of *I. gurneyi* were observed in the laboratory. Two were successful, occurring at 10:22 AM (DST) (Mt. Ashland, Oregon) and 11:10 AM (DST) (Condrey Mtn., California). On

three occasions individuals were placed together in mid afternoon (2:00-3:00 PM) but failed to show any interest in courtship. Mating in this species occurs on a horizontal surface, with palpation followed by copulation, a short period of titillator activity and spermatophore formation, then separation. No abdominal stroking by males was observed.

I. gurneyi was found in local aggregations near tree line on the south slope of Mt. Ashland, Oregon. At lower elevations no specimens were found. The vegetation of the two areas is considerably different. At lower elevations dense coniferous forests and seepage springs with heavy herbaceous vegetation predominate, with heavy, wet, clay soil. The type locality is considerably better drained with loose, rocky soil and sparse vegetation. Laboratory observations regarding the necesary conditions for proper egg development indicate that soil moisture would probably not exclude the species from lower elevations.

Idiostatus wymorei Caudell (Figs. 15, 22, 55, 56, 87)

Idiostatus wymorei Caudell, 1934, p. 156, fig. 7.

Type data. — Three labels. 1. (handwritten) "Strawberry, El Dorado Co., Calif., September 14, 1934. F. H. Wymore." 2. (printed red USNM type label) "no 50739." 3. (handwritten) "Idiostatus wymorei holotype Cdll."

Type locality. — Strawberry is located on U.S. Highway 50 in the Sierra Nevada Mountains, 7,000 feet elevation.

Deposition of primary types. — The holotype and allotype are in the U.S. National Museum, number 50,739.

Diagnosis. — Size medium for genus, form robust, squarish. Coloration in two phases usually in equal numbers; green phase phaneropterine green without markings on outer pagina of hind femur, without abdominal ring; brown phase often with lighter dorsal, longitudinal stripe; outer pagina of hind femur with longitudinal stripe, abdomen ringed. Males distinctive in the following characters; middle tibia armed dorsally with two spines on anterior margin, these occupying proximal one-third of leg; tergite ten with shallow median incision, lateral lobes broadly rounded; cercus (fig. 22) dorso-ventrally flattened, median tooth well indicated, apex acute not prolonged; titillator (figs. 55, 56) with base moderately developed, arm very elongate or only as long as base, bowed with widely separated teeth from midpoint to apex. Females may be identified by the following combination of characters: one or two longitudinal veins in tegmen, these undulant, bowed apicad; tergite ten with deeply incised V-shaped

incision; cercus conical, three and one-half times longer than broad, apical one-fourth narrowed; ovipositor straight, slightly longer than hind femur. *I. wymorei* is an inhabitant of meadows or forest clearings of the yellow pine and lodgepole fir belts of the central Sierra Nevada Mountains of California (Storer and Usinger, 1963) (Map 2).

Species description. — MALE. Size medium for genus, form robust. HEAD moderately amplected in pronotum. First antennal segment three times broader than second, twice as long. PRONOTUM dorsally smooth, area delimited by lateral carinae slightly concave; humeral angles on posterior one-third as abruptly rounded shoulders, lateral lobes broader than long, caudal margin weakly undulant, convex callosity of lateral lobe weak or absent; ventral margin rounded, gently sloping dorsad anteriorly. TEGMINA protruding beyond posterior margin of pronotum for one-half to two-thirds dorsal length. LEGS short; hind femur protruding beyond apex of abdomen less than one-quarter length of femur. Ventral anterior surface of fore femur unarmed or with one to three minute teeth. Hind tibia dorsally with 19-20 closely spaced, uncinate spines on inner margin, outer margin with 21-22 spines, proximal spines short, dentate, distal spines alternately of two sizes; outer margin of ventral surface with six to seven widely spaced spines, inner margin with seven to eight spines; outer ventral surface of hind femur with two to three teeth, inner margin with two to six randomly spaced teeth. Plantula of hind tarsus circular, one-fourth length of metatarsus. Proximal tarsal segment as long as next two combined; distal segment as long as first three segments. ABDOMEN dorsally smooth, with weak indication of dorsal carina, this likely due to wrinkling in drying. Dorsum of tergite ten (fig. 22) with soft integumental portion pilose. Cercus (fig. 22) pilose. Subgenital plate V-shaped, median excavation one-fifth length of plate; styles as long as inner margin of incision. Styles and dorsal margins of subgenital plate pilose. Titillator as in fig. 55. COLORATION. Green and brown color phases present in nearly equal numbers. Head of both phases uniform brown, often speckled with lighter brown. Exposed portions of mandibles light brown, almost white; clypeus and labrum darker brown. Vertex light brown, often speckled with green. Pronotum and abdomen uniformly green or brown, some specimens uniformly brown with pale dorsal stripe as wide as broadest portion of pronotum extending from vertex of head to abdominal apex. Meso- and metathoracic areas adjacent to thoracic auditory structure often black. Posterior portions of lateral lobes of pronotum frequently black with white margin, but often unmarked. Tegmina uniformly reddish brown, main veins slightly darker. Cercus and subgenital plate and abdomen concolorous, either brown or green. Legs uniformly brown or green, similar to dorsum of abdomen, with ventral bases of fore and middle femora and dorsum of base of hind femur black. Plantula cream or light straw brown, apex darker. Venter light brown.

Holotype measurements. — From Caudell (1934:156). Length: body, 20.00; pronotum, 6.00 × 4.50; hind femur, 16.00; exposed tegmen, 4.50.

FEMALE. Similar to male with following exceptions: tegmen protruding

beyond pronotum less than one-eighth dorsal length of pronotum. Surface of tegmen with one-half longitudinal veins in lateral one-third, these undulant or bowed apically. Tergite ten deeply incised, excavation V-shaped, lateral lobes subacute. Cercus conical, three and one-half times longer than broad, apical one-quarter narrowed. Cercus pilose. Subgenital plate broader than long, incised medially to one-fourth of its length; ventral lobes broadly rounded. Ovipositor straight, dorsally declivous apically, with tuberculations or serrations less developed on dorsal and ventral margins.

Allotype measurements. — From Caudell (1934:156). Length: body, 21.00; pronotum, 6.00 × 4.50; hind femur, 17.00; ovipositor, 22.00; exposed tegmen, 0.50.

Variation. — A single topotype male has black marking on the dorsum of the distal abdominal tergite forming a weak black ring. The titillators vary from the condition in the topotypes, from specimens from Leland Meadow, California, which are serrated along the entire arm. The single male from Tuolumne Meadows, California, has the titillator with the outer margins of the arms twisted dorsad and more abruptly bowed basad. The apex is truncate, narrowed subapically. Among specimens from near Echo Lake, California the arm of the titillator may be short with serrations along the outer margin or elongate and twisted with the serrate margins aligned dorsally.

Seasonal occurrence. — Adults of *I. wymorei* have been taken at the type locality between 5 September and 10 October. Adults may occur earlier than September depending on local weather conditions. At higher elevations in years of heavy snowfall, eggs are probably retarded in hatching; likewise early snowfalls in the autumn may prematurely kill the adults. However, activity may occur at low temperatures. In 1965 when the author collected topotypes, no snow had yet fallen but temperatures dipped to freezing at night. Nevertheless, males were stridulating by 10:00 AM, ambient temperature 68°F. At lower elevations, such as Yosemite National Park, adults are recorded as early as 1 August.

Song. — Males sing from mid to late morning, often in small localized groups. They are very wary and slow the pulse rate or stop singing altogether when disturbed.

Distribution. — *I. wymorei* is known from several localities in the central Sierra Nevada Mountains of California, west of the crest (Map 2).

Records. — CALIFORNIA: EL DORADO COUNTY: Strawberry, 5,700 ft. elev., 14 September 1934 (F. H. Wymore, 7 ♂♂, 6 ♀♀, holotype, allotype, paratypes, CAS, USNM); 10 October 1965 (D. C. Rentz, J. D. Birchim, 18 ♂♂, 1 ♀, DCR); 5 September 1968 (D. C. & K. A. Rentz, 3 ♂♂, DCR). Echo

Lk., east end nr. Public Camp, 7,000 ft. elev., 10 October 1965 (D. C. Rentz, J. D. Birchim, 6 ♂♂, DCR). MARIPOSA COUNTY: Yosemite National Park, 1 August 1940 (D. E. Hardy, L. C. Kuitert, L. J. Lipovsky, 3 ♂♂, 1 ♀, 2 ♀♀ last instars, ANSP, UK). Tuolumne Mdws., 14 rd. mi. W., 8,000-9,000 ft. elev., 25 August 1957 (T. J. Cohn, 1 ♂, UM). TUOLUMNE COUNTY: Leland Mdws., 5 August 1960 (D. Q. Cavagnaro, 13 ♂♂, 1 ♀, CAS, JRH).

Specimens studied. — 62, including holotype.

Hosts. — At the type locality *I. wymorei* were found associated with a sedge (most likely *Carex nebraskensis* Dewey) which was the predominant plant growing in the open meadows. At Echo Lake, California, *I. wymorei* inhabited small clearings in the conifer forest. Dominant plants in the clearings were *Ceanothus* sp. and other large chaparral bushes, with mules ears, *Wyethia mollis,* growing in exposed areas. The katydids were found exclusively in the mules ears hiding in the dry, dead leaves when disturbed.

Discussion. — *I. wymorei* is closely related to *I. gurneyi* of the north which occurs in somewhat similar ecological conditions but is less likely to be found in proximity to coniferous forests. *I. wymorei* could also be confused with a *Steiroxys* which occurs in Lassen National Park, California. This species of *Steiroxys* inhabits sedges in moist situations similar to those along the margins of the type locality of *I. wymorei.* Although strikingly convergent to *Idiostatus* in overall appearance and genital structure this species is placed in the genus *Steiroxys* by the presence of lateral carinae on the anterior margin of the pronotum, the apical fingers of the subgenital plate of the female, the lanceolate form of the tegmen of the female, and the bimodal pattern of the calling song of the male (Plate 1). The courtship behavior of the *Steiroxys* species is similar to that typical of diurnal *Idiostatus* species. However, as stated in the introduction, this may be a generalized pattern found throughout the subfamily.

I. wymorei is a ground dwelling species found in groups of "colonies." It is sexually active from mid to late morning. Captive individuals showed no interest in courtship in mid-afternoon although males sing in the field at this time.

Idiostatus californicus Pictet (Figs. 2, 9, 15, 23, 53b, 88; Plate 1)

Idiostatus californicus Pictet, 188, pp. 64-65, figs. 35, 35a, 35b.

Idiostatus hermannii, of authors since 1894, not of Thomas, 1875, p. 904, pl. v, fig. 65.

Type data. — Lectotype male here designated from two pinned specimens once preserved in alcohol and now faded to a light straw brown. The specimen selected as the lectotype is apparently the one figured by Pictet in the original description (fig. 35b) since the cerci are dried precisely as drawn in that figure. No indication was given in the original description of the existence of more than one specimen.

Type locality. — Although "California" was originally designated the type locality, Scudder (1894), Caudell (1907) and Hebard (1934) gave the impression that material representing this species was described from Mt. Shasta. They also incorrectly assumed *I. californicus* to be a synonym of *I. hermannii*, but careful examination of the original description readily demonstrates the two are different and is discussed more fully under *I. hermannii*.

Since *I. californicus* is abundant in the Mt. Shasta City area (it does not extend very far up the western slope of the mountain), it seems justified to restrict the type locality of *Idiostatus californicus* Pictet to Mt. Shasta City.

Deposition of lectotype. — The lectotype and cotype are in the Geneva Museum of Natural History, Geneva, Switzerland.

Diagnosis. — Size large for genus, form moderately robust. Coloration either uniform phaneropterine green or brown; eyes and tegmina uniform reddish brown, the veins not contrastingly colored. Males are distinctive in the following characters: tegmen elongate, one-half to three-quarters as long as pronotum; tergite ten with black ring, better developed laterad, in darker brown specimens tergite eight, nine often black laterad; cercus (fig. 23) dorso-ventrally flattened, internal tooth in apical one-third; titillator with base little developed, serrated along entire outer margin, arm nearly straight. Females may be identified by the following combination of characters: tergite ten with rather large V-shaped medial incision; cercus conical, apex somewhat acute, not spine-like, broadest in basal two-thirds, feebly directed outward; subgenital plate (fig. 88); ovipositor longer than hind femur, straight or feebly decurved.

Description of lectotype. — HEAD smooth, not punctate, but with irregular shallow depressions. Fastigium of vertex broad, projecting slightly beyond first antennal segment, with small medial depression. Width of fastigium nearly equal to that of first antennal segment. Eyes round, slightly longer dorso-ventrally. First antennal segment broad, half as long as third. PRONOTUM deplanate dorsad, with slight medial posterior depression; lateral ridges not well indicated, present only on posterior one-half of dorsum of disk; anterior margin of disk slightly truncate; anterior margin of lateral lobe straight, not concave, posterior margin undulant, concave; posterior margin of disk truncate, without median notch. TEGMINA projecting for a distance of more than half the

length of pronotum, venation net-like in outer margin. APPENDAGES. Fore tibia unarmed dorsally on anterior margin, posterior margin armed with three widely spaced spines; ventral surface armed with six spines on both anterior and posterior margins. Fore femur armed on anterior margin of ventral surface with three teeth. Middle tibia armed dorsally with two spines on anterior margin, posterior margin with four spines; ventral surface armed on both margins with six spines. Middle femur armed on anterior ventral surface with two to three spines. Hind tibia armed dorsally with numerous spines on inner and outer margins; ventral surface armed with six spines on inner margin, outer margin with nine spines. Apex of hind tibia armed with two stout apical calcars on dorsal surface, these of nearly equal length; ventral surface with four such calcars, the innermost spur slightly longer than the outermost, the inner pair only half as long as outermost spur.

Lectotype measurements. — Length: 24.00; pronotum, 6.75 × 4.75; hind femur, 22.00; exposed tegmen, 5.00.

Species description. — MALE. Size large for genus, form rather slender to moderately robust. HEAD. Fastigium of vertex one-half to two-thirds as broad as interocular distance, prominent, broadly obtuse dorsad. Eyes moderately bulging, almost wholly round. Frons and genae rather densely pitted. First antennal segment two and one-half times broader than second, less than half again as long. PRONOTUM dorsally only slightly depressed in posterior one-third, not polished. No traces of lateral carinae at humeral angles but distal one-quarter of pronotum bent indicating such; lateral lobes slightly longer than broad. Posterior margin of lateral lobe nearly straight, but slightly declivent postero-dorsally; ventral margin broadly rounded, slightly sloping more anteriorly. Posterior margin of pronotum truncate, without indication of medial notch. Plantula of hind tarsus feebly developed, less than one-fourth the length of metatarsus. ABDOMEN dorsally smooth, without indication of dorsal carina. Dorsum of tergite ten with median area membranous, densely pilose. Cercus (fig. 23) pilose, the hairs much shorter than those on dorsum of abdominal areas. Subgenital plate scoop-shaped, longer than broad; V-shaped median excavation one-sixth as deep as length of plate itself; styles elongate, slightly longer than length of one margin. TITILLATOR (fig. 53b). COLORATION. The most commonly encountered color phase is phaneropterine green over entire insect with following exceptions: eyes brown, antennae straw brown; posterior and ventral borders of pronotum lemon yellow. No black on humeral angle of pronotum of green specimens. Tegmina uniform reddish brown. Dorsum of tergum ten straw brown, medial membranous section slightly darker with purplish tinge. Black markings of dorsum of abdomen on lateral portions of tergum ten, poorly indicated. Cerci light straw brown, apex of inner tooth dark brown to black. Subgenital plate and entire ventral portion of abdomen light greenish yellow.

Specimens of the brown phase are usually wood brown uncommonly with two light yellow brown stripes similar to those seen in *I. inermis*. Brown phase specimens always possess a black area in the humeral region of the pronotum,

and black lateral areas of tergites eight, nine, ten.

FEMALE. Similar to male but larger. Tegmen protruding beyond posterior of pronotum for a distance of one-fifth to one-sixth of dorsal pronotal length. Tergite ten incised in median portion. Supra-anal plate slightly longer than broad, apex broadly acute. Cercus conical, elongate, four to five times longer than basal width; apex slightly concave on outer margin rendering a slightly outcurved appearance. Subgenital plate narrow (fig. 88). Ovipositor very long, as long or longer than hind femur, straight to somewhat decurved in some specimens; ovipositor tuberculate on apical one-fourth to one-fifth laterally and dorsally. Coloration in two phases as described for male. Ovipositor usually light brownish, apical one-fifth black. Females of the green phase lack black markings of abdominal tergites as described in male. Females of the brown phase have black marks laterally on abdominal tergites eight, nine, ten.

Variation. — Little morphological variation has been noted among individuals of either color phase of *I. californicus.* Some males from Trinity County show a reduction in the width of the shaft of the cercus and inner tooth to a more slender structure. However, its basic morphology is the same. Some variation in color intensity is readily detectable and collecting the two color forms in any given locality will reveal a small percentage of straw brown or lemon yellow individuals seemingly intermediate between the two color forms.

The most obvious variation noted in *I. californicus* is that of size which is apparently correlated with altitude. Populations at lower elevations, such as those from 150 ft. elev., Glenn Co., Calif., are characteristically larger than those from 6,000 feet elevations at Plaskett Mdws. in the same county. (Table 7.)

Some indication of the factors controlling size can be seen in laboratory reared specimens from Plaskett Meadows. Nymphs collected at an early stage and reared on dry dog food grew to a larger size when compared with field collected adults of the same year.

Color in *I. californicus* seems to be under environmental influence. Almost inevitably, green katydids will be found among green foliage such as bracken fern (Mt. Shasta City, California, and seepage areas near Plaskett Meadows, California) while brownish individuals will be encountered in drier situations. A series taken six miles west of Plaskett Meadows, 6,200 feet elevation, 11 October 1964, on dry brown *Stipa columbiana* McCoun demonstrated this. A series of 21 males was collected in a small area. Fourteen were of the brown phase and were collected on the grass itself. The remaining seven were a dull green, almost a light brown color, not at all as intense as seen among populations in more moist situations where there is abundant green foliage. All of the green katydids were collected in adjacent drying herbaceous vegetation consisting of drying bracken and unidentified low shrubbery.

Chromosome number. — 2N = 29. A male from South Fork summit, Trinity County, California, had the following chromosome complement: 2V + 26R + XV = 29.

EGGS. — Eggs laid by captive females lie between 77-80 (medium yellow brown) on the ISCC-NBS Color Chart. Measurements in Table 9. Two cap-

tive females from six mile road, Eddy Gulch, Siskiyou County, California, collected in 1968 as adults laid 11 eggs and 99 eggs respectively between the dates 16 September and 7 October. The first female died 18 September, the second 7 October.

Seasonal occurrence. — Appearance of adults is greatly dependent upon seasonal progression at the locality in question. Earliest adult records are 23 June (Central Valley locality west of Artois, California, 150 ft. elev.); the latest known date for adults is 11 October (six mi. west Plaskett Mdws. Station, 6,200 ft. elev.).

Song. — *I. californicus* has primarily two different calls. A short, sharp zic (fig. 1F) elicited by courting males, single isolated males, or by males during early hours of the evening. Groups of males often sing in unison during warm morning hours with a continuous buzz. This is obviously the calling song since mating occurs at this time.

Distribution. — *I. californicus* has one of the broadest ranges of any species in the genus (fig. 15). It occurs primarily in the Yellow Pine Belt of Storer and Usinger (1963), usually considered the Transition Zone by most authors. On Mt. Shasta, California, *I. californicus* is restricted to the Yellow Pine Belt and does not occur up the mountain into the Lodgepole Pine-Red Fir belt (Canadian zone) presumably because of the considerably lower temperatures. It is found in mountain chaparral ecological associations especially where manzanita, bush chinquapin, and *Ceanothus* occur. *I. californicus* can also be found in sagebrush associations where this plant community meets chaparral as in Siskiyou (ten mi. north Weed, California) and Glenn counties (six mi. west Plaskett Mdws. Station). *I. californicus* has apparently made incursions into the Central Valley along its western margin in grassland situations.

Records. — CALIFORNIA: DEL NORTE COUNTY: Smith River, seven mi. N., 21 July 1964 (J. Anderson, T. R. Haig, 1 ♂, 1 ♀, last instars, CDA). GLENN COUNTY: Artois, four mi. NW., 23 June 1954 (K. G. Whitesell, 1 ♂, 1 ♀, ex: dry grass, CDA). W. of Artois, 26 June 1954, 23 June 1955 (K. G. Whitesell, 2 ♂♂, 3 ♀♀, ex: dry grass, CDA #54F480). Covelo, 25 mi. E., 28 June 1961, matured July 1961 (D. C. Rentz, 3 ♂♂, 3 ♀♀, DCR). Highway 99W, five mi. W., 25 June 1957 (N. Love, 1 ♂, 1 ♀, CDA #57F2722). Just east of Mendocino Pass, 27 August 1961 (J. R. Helfer, 2 ♂♂, 1 ♀, JRH). Plaskett Mdws., two mi. W., 27 August 1961 (D. C. Rentz, 4 ♂♂, 2 ♀♀, DCR); six mi. W., 6,200 ft. elev., 11 October 1964 (D. C. & K. A. Rentz, J. D. Birchim, 27 ♂♂, ex: *Stipa columbiana* MaC., DCR). Willows, June 1954 (K. G. Whitesell, 9 ♂♂, 2 ♀♀, 1 ♀ last instar, CDA). HUMBOLDT COUNTY:

Fieldbrook, 10 August 1965 (B. Brothers, 2 ♀♀, 1 ♀ last instar, CDA). South of Bridgeville, 18 July 1955 (F. Nonini, 1 ♀, ex: range, CDA #55H672). MENDOCINO COUNTY: Mendocino Pass, 26 July 1961 (J. R. Helfer, 1 ♂, 1 ♀: 3 ♂♂, 2 ♀♀ last instars, JRH). PLACER COUNTY: Blue Canyon, 4,700-5,000 ft. elev., 29 August 1910 (2 ♂♂, ANSP). PLUMAS COUNTY: Johnsville, 5,200 ft. elev., 8 August, 23 August 1959, 2 September 1959, 29 July 1960, 3 September 1960, 10 August, 25 August 1961, 9 September 1961, 20 August, 23 August 1964, 11 September, 20 September 1964 (W. Bauer, J. S. Buckett, H. Pini, 79 ♂♂, 9 ♀♀, JRH, UCD). SISKIYOU COUNTY: Castle Lk., 5,100 ft. elev., October 1953 (H. Chandler, 2 ♂♂, CAS). Cecilville, eight mi. NE., 5 September 1968 (G. Buxton, K. Goeden, A. Gurney, 6 ♂♂, 2 ♀♀, ODA). Eddy Gulch Lookout, 5 September 1968 (G. M. Buxton, A. B. Gurney, 1 ♂, USNM). Gazelle, 2 September 1942 (H. W. Graves, 1 ♂, CIS). McBride Camp, four mi. E., Mt. Shasta City, 23 July 1962, 26 August 1965 (D. C. & K. A. Rentz, C. D. MacNeill, 12 ♂♂, 3 ♀♀, DCR). Mt. Shasta, 5,500 ft. elev., September 1885 (J. Behrens, 1 ♀, ANSP); 14 August 1909 (3 ♂♂, 3 ♀♀; 2 ♂♂, 2 ♀♀ last instars, ex: undergrowth in pinewoods, ANSP). Mt. Shasta City, west end of town, 3,700 ft. elev., 26 August 1965 (D. C. & K. A. Rentz, 4 ♂♂, 7 ♀♀; 1 ♂ last instar, DCR). Shasta Range, Upper McCloud River, August 1916 (J. A. Kusche, 11 ♂♂, 5 ♀♀, ANSP). Sisson, base of Mt. Shasta, 24 July 1906 (Dyar & Caudell, 1 ♂ last instar, USNM). Two mi. E. Jct. Hwy. 97 & Military Pass Rd., 27 July 1965 (D. C. Rentz, 1 ♂, DCR). Six mile area, below Mt. Eddy, 5 September 1968 (G. M. Buxton, A. B. Gurney, 1 ♂, 2 ♀♀, USNM). Trinity Center, seven mi. S., 26 July 1954 (J. A. Powell, 1 ♂, CIS). TRINITY COUNTY: Bully Chup Peak, 20 September 1966 (M. R. Gardner, 2 ♂♂, UCD). East Weaver Lk., 25 September 1964 (F. L. Blanc, G. M. Buxton, 1 ♂; 3 ♀♀ last instars, CDA). Grizzly Lk., 11 September 1964 (G. M. Buxton, W. Forbes, A. B. Gurney, W. Kamp, 3 ♂♂, CDA #64129-28). Grizzly Mdws., 10-15 September 1964 (G. M. Buxton, A. B. Gurney, 2 ♂♂, 1 ♀; 1 ♀ last instar, CDA #6412729). Lamb Gap, South Fork Mtn., 19 September 1962 (G. M. Buxton, F. L. Blanc, 27 ♂♂, 30 ♀♀; 2 ♀♀ last instars, CDA). South Fork summit, Hwy. 26, 4,077 ft. elev., 18 August 1966 (D. C. & K. A. Rentz, 20 ♂♂, 5 ♀♀, DCR). Weaver Bally, 8 September 1964 (G. M. Buxton, A. G. Forbes, A. B. Gurney, W. Kamp, R. Thompson, 3 ♂♂, 1 ♀, ex: serpentine area, CDA).

Specimens studied. — 340, including lectotype.

Hosts. — *I. californicus* has been collected on a variety of ecological situations ranging from montane chaparral to valley grassland. The species has been noted feeding on *Stipa lemmonii* (Vasey) Scribn. and *S. columbiana* McCoun as well as bracken fern and berries of red cherry.

Discussion. — One of the most interesting records for an *Idiostatus* species is the record of *I. californicus* from the Sacramento

Valley of northern California during the 1950's. As can be seen from Table 6, these specimens are gigantic in size. Possible reasons for this are discussed in the "Variation" section. One of the areas from which specimens were collected was visited after consulting the records of the California State Department of Agriculture. The Michael family ranch, located approximately five miles west of Artois, was visited on 6 July 1968. Miss Georgiana Michael directed the author to the exact area where the katydids had been so numerous. She stated (personal communication) they had been so abundant in 1955 that they perched on fenceposts and frequently could be seen crossing roads during the day. My trip to this locality proved fruitless for the collection of specimens. It was difficult to imagine that any species of *Idiostatus* would find such a habitat hospitable. The topography of the area is generally flat, with low rolling hills and intermittent broad gullies. Large vegetation consists of mature deciduous oaks which are rather widely scattered. Grasses form the major vegetation of open areas with a considerable amount of tarweed in concentrated patches. The ranchers use the area mostly for sheep grazing. Orthoptera present at the time of my visit were typical of the Valley Grassland habitat. They included *Oedaleonotus enigma, Melanoplus devastator, Dissosteira spurcata, Clinopleura infuscata.* Rainfall during the mid and late 1950's was above average and perhaps such a series of favorable years could have been responsible for permitting the populations of the adjacent western mountains to extend their ranges into the Valley. The nomadic tendencies noted in some populations of this species provide evidence of potential range-extending behavior. Perhaps the series of dry years of the early and mid 1960's was enough to kill off the population in the Valley. Another possible explanation rests with the diapausing ability of the eggs. As discussed in the introduction, there is evidence to indicate that eggs of *Idiostatus* can remain in diapause for at least several years. In an area of sporadic wet years, such as the western portion of the Sacramento Valley, eggs may remain in the ground for many years until the necessary moisture threshold is attained.

Observations made by G. M. Buxton (personal communication, 1962) on *I. californicus* at Lamb Gap, California, illustrate the nomadic tendencies of the species. He stated that the entire population, which was unusually large, seemed to be moving down the mountain

in a southerly direction at midday. Buxton stated the katydids were intent on their movement and made little attempt to hide when approached.

Eggs of *Idiostatus californicus* hatch in early to late spring, depending upon local weather conditions. Adults are found throughout the summer and fall until they are killed by frosts. *I. californicus* is a diurnal species, mating in mid morning to mid afternoon. At least two different calls are readily discernible. One, a continuous buzz (fig. 112A) is the calling song heard during the morning hours. Another is a "zic" call irregularly emitted both during the day and night hours prior to midnight. Males commonly "zic" at night until the temperature becomes too low for activity. Since mating does not occur at night in the laboratory, it is thought that the "zic" calls have an aggregative effect, keeping the population together in a small area. *I. californicus* does not wander at night as do many other species. Intensive road collecting at night in the Mt. Shasta City area where *I. californicus* populations are present has not yielded a single wandering individual although many males could be heard "zicing" in the adjacent vegetation.

As previously stated, *I. californicus* inhabits chaparral and grassland situations. At Mt. Shasta City is was found in dense thickets, mostly *Ceanothus,* bitterbrush and red cherry. Low clearings or roadside shoulders with dense bracken, *Pteridium aquilinum,* also harbored many. Examination of the gut contents of specimens collected at McBride Camp showed that the population had been feeding largely on the fruits of red cherry, *Prunus emarginata.* The mandible of a male from near Plaskett Meadows, California (fig. 2), matches the Carnivorous-Forbivorous category established by Gangwere (1965). The molar concavity of this species is rather well indicated. The relationship of food preference and mandibular type is discussed in the introduction.

Late in the summer and early fall stridulating males can often be seen sitting atop dry grass a distance of a foot or two from the ground. At a locality near Plaskett Meadows in 1964, a large aggregation was found on a hillside vegetated largely by *Stipa columbiana* McCoun. The katydids were extremely wary and stopped calling, rendering only short "zics" at the slightest disturbance. If sufficiently disturbed, they dropped to the ground and sought cover in the litter. Similarly the

series from South Fork Summit was taken on a hillside consisting mostly of the dry grass *Stipa lemmonii* (Vasey) Scribn.

Idiostatus fuscus Caudell (Figs. 15, 24, 57, 89)

Idiostatus fuscus Caudell, 1934, p. 154, fig. 8.

Type data. — Five labels. 1. (handwritten) "Ralston Peak, Cal., October 13, 1932." 2. (printed) "C. C. Wilson, col." 3. (printed) "Sacramento no. 3297." 4. (printed red USNM type label) "NO. 44902." 5. (handwritten) "Idiostatus fuscus Cdll. ♂ holotype."

Type locality. — Ralston Peak is located three airline miles southwest of Fallen Leaf Lake, El Dorado County, California. There is no indication in the original description of the exact elevation at which the type series was taken.

Deposition of primary types. — The holotype and allotype are in the U.S. National Museum, No. 44,902.

Diagnosis. — Size medium, form robust. Coloration in life dark wood brown, often becoming greyish in museum specimens; green forms known only as nymphs. Tegmen reddish brown to light brown, veins usually unicolorous. Both sexes possess a highly polished mottled grey pronotum with black marking on lateral lobe; tergites eight, nine, ten black laterally, obsolete mesad; females may also have tergum seven black; outer pagina of hind femur with broad black stripe on dorsal one-half only. Males distinctive in following characters: tergite ten soft, pilose, lobes not well produced; cercus (fig. 24) with stout median tooth, apex well produced, acute; titillator (fig. 57) with base moderately developed, arm elongate, with widely separated teeth placed dorsad; dorsum of tergum ten soft, pilose, lobes not well produced. Females may be identified by the following combination of characters: tegmen with three to four longitudinal veins bowed laterad; cercus conical, base stout, distal two-thirds attenuate, apex straight or weakly directed outward; subgenital plate (fig. 89) not deeply incised; ovipositor longer than hind femur. *I. fuscus* is an occupant of the Sagebrush community of the higher elevations just below tree-line in the central Sierra Nevada Mountains of California (fig. 15).

Species description. — MALE. Size medium for genus, form robust. HEAD. Fastigium of vertex two-thirds as broad as interocular distance, prominent, lateral sulcation at base shallow, obscure. Eyes not bulging, slightly elongate dorso-ventrally, two and one-half times longer than width of first antennal segment. First antennal segment three times broader than long, slightly more than one and one-half times as long. PRONOTUM. Disk of pronotum concave mesad, highly polished; humeral angles indicated on posterior one-quarter as rounded shoulders; lateral lobes as long as broad, posterior margin abruptly declivent, ventral margin gently sloping upward anteriorly. APPENDAGES. Legs appearing shorter than normal; hind femur protruding only slightly beyond

apex of abdomen. Fore femur usually unarmed ventrally but a single specimen possesses three small teeth on anterior margin. Middle femur unarmed or with up to three teeth on anterior surface. Hind tibia armed dorsally with 21-22 spines on inner margin, outer margin with 19 spines; ventral surface armed with four spines on inner margin, eight spines on outer margin, the subapical spines of both margins spur-like. Plantula two and one-half times as long as basal width, nearly half as long as metatarsus, apex acute. Proximal tarsal segment only slightly longer than second segment; distal tarsal segment longer than second and third segments combined. ABDOMEN dorsally smooth, without indication of dorsal carina. Dorsum of tergite ten with membranous shallow median excavation; lateral margins not developed into lateral lobes; soft integumental median portion densely pilose. Cercus (fig. 24). Subgenital plate longer than broad; V-shaped median excavation less than one-fifth length of plate; styles less than length of one margin of V-shaped medial incision. Styles and margins of subgenital plate pilose. Titillator (fig. 57). COLORATION. General coloration brown, no green in adults. Head light brown, streaked with black around perimeter of eye; some specimens with black flecks on eyes. Pronotum reddish brown in posterior portion; anterior portion of lateral lobe light brown or yellow brown; humeral angle well marked with black, posterior margin whitish. Tegmen uniform reddish brown, the larger distal veins somewhat darker. Lateral portions of thorax spotted black. Fore and middle femora light brown with several black spots forming a stripe, these often coalesced. Tibia light grey brown with black spots indicated infrequently at the bases of spines. Hind femur grey brown with broad black stripe on dorsal one-half of outer pagina. Abdomen generally brown dorsally, often fading to grey in death; lateral portions of tergites one to four frequently with black flecks; tergites eight to ten heavily marked with black giving the abdomen a black ringed appearance. Median portion of tergum ten light brown. Cercus uniformly reddish brown; apex of median tooth black. Ventral portions of thorax and abdomen and subgenital plate reddish brown. Lateral portions of abdominal sclerites with black spot or stripe.

Holotype measurements. — From Caudell (1934:155-156). Length: 17.00; pronotum, 5.50 × 4.50; hind femur, 13.00; exposed tegmen, 3.30.

FEMALE. Similar to male but differing in the following characters: tegmen protruding from pronotum for a distance of one-sixth to one-fourth the dorsal length of the pronotum; tegmen with three to four, usually three, major longitudinal veins, these bowed laterad; dorsum of tergite ten little differentiated; cercus elongate, basal two-thirds robust, thickened, distal one-third abruptly narrowed, apex acute, straight or weakly directed outward. Subgenital plate as long as broad (fig. 89). Ovipositor straight, as long or slightly longer than hind femur, tuberculate in apical portion. Coloration as in male except ovipositor uniformly wood brown, extreme apex somewhat darker.

Allotype measurements. — From Caudell (1934:155-156). Length: body, 22.00; pronotum, 5.50 × 4.50; hind femur, 16.00; exposed tegmen, 1.00; ovipositor, 19.00.

Variation. — The small series before me shows considerable variation in the number of spines present on the dorsum of the tibiae, the numbers given being typical. A single specimen may vary one or two spines from these numbers. In other characteristics the series seems remarkably similar.

Seasonal occurrence. — Adults of *I. fuscus* have been taken from 10 August (Blue Canyon, Sonora Pass, California) to 13 October (Ralston Peak, California). This species occurs at high elevations in the Sierra Nevada Mountains of California. Eggs likely hatch soon after snow melts. The longevity of adults is also likely dependent upon local arrival of cold weather in the fall.

Song. — *I. fuscus* is a diurnal species, the chill of its high mountain habitat appears to inhibit nocturnal activity. Stridulating males may be found in small groups usually in big sagebrush, *Artemisia tridentata.* The call is a buzz, very low in intensity, sounding somewhat like that of *I. inermis.* Individuals are very alert and stop singing at the slightest disturbance.

Distribution. — *I. fuscus* is known from several scattered localities in the Sierra Nevada Mountains, California, and has been taken at elevations ranging from 9,000-10,400 feet. The northern record for the species is the type locality; it has also been taken as far south as Sonora Peak, California (fig. 15).

Records. — CALIFORNIA: ALPINE COUNTY: Carson Pass, 13 October 1951 (H. H. Bastel, 1 ♀, CIS). Lake Winnemucca, 20 August 1964 (I. Savage, 6 ♂♂, 1 ♀, all last instar nymphs, CDA). EL DORADO COUNTY: Grass Lake, one mi. SW. Glen Alpine, 8,000 ft. elev., 27 August 1947 (H. P. Chandler, 1 ♂, CAS). Ralston Peak, 13 October 1932 (C. C. Wilson, 2 ♂♂, 3 ♀♀, paratypes, CAS, USNM). MONO COUNTY: Monitor Pass, one mi. E., 8 September 1964 (M. R. Gardner, 1 ♂, UCD). TUOLUMNE COUNTY: Sonora Pass, 1 September 1955 (W. E. Simonds, 1 ♀, CDA); Blue Canyon, 10,400 ft. elev., 10 July 1960 (D. Q. Cavagnaro, 1 ♂, 1 last instar ♀, JRH); 30 August 1960 (C. A. Toschi, 1 ♂, CIS); south slopes, 5, 7 September 1960 (D. C. Rentz, 6 ♂♂, DCR).

Specimens studied. — 25, including holotype.

Hosts. — I have found this species associated with big sagebrush and snow berry, *Symphoricarpos* sp. at Sonora Pass, California.

Discussion. — Little is known of the habits of this species due to its rather secretive nature and unpredictable occurrence. The Sonora Peak, California, location was visited at different times during the summer and early September in 1961, 1962, 1965, 1966, 1967, 1968 in order to obtain additional material for cytological and biological

study. The same area and same plant species were examined on each occasion but no katydids were found after 1960. Several of the succeeding years were very dry. It is worth mentioning that in 1960 a series of the then undescribed grasshopper *Hypsalonia miwoki* Gurney and Eades was collected in the same general region where *I. fuscus* was then found. The grasshopper was present in large numbers suggesting at that time that it was a common but somehow overlooked inhabitant of that area. At no time since that date were specimens of *H. miwoki* found in such abundance. In 1962 a few were found after intensive searching and none have been taken since.

I. fuscus is not really closely related to any other known species of the *californicus* Group, its uniform brown color in life seen only in *I. gurneyi*. Green forms have not been seen among adults. The series of nymphs from Lake Winnemucca, California, contains a single green third or fourth instar nymph illustrating the presence of such color among juveniles.

The *hermannii* Group

The three species of this group (*I. variegatus, I. hermannii, I. inermoides*) are residents of the central and northern Great Basin (fig. 16). They are most typically associated with the Greasewood-saltbush plant community of Küchler (1964) but the nominate species occurs in the sagebrush steppe community as well. The species seem to be sporadic in their appearance, present in large numbers during certain years and absent from the same locality in others. All are thamnophilous and colonial. The group is characterized by the nomadic tendencies of its members, an entire population moving from one area to another during the course of a single season. Each of the three species is diurnal with regard to mating but some stridulation and feeding occurs at night.

Morphologically, members of the *hermannii* Group all possess a similar color pattern (Plates 4, 6) with populations containing a high percentage of green individuals. All males have the titillator with a well developed base, the arm well serrated (figs. 58-62). Males show little specialization of the tenth abdominal tergite. Females have a short ovipositor relative to the length of the hind femur and the subgenital plate with a well defined median notch (figs. 90-92).

FIG. 16. — Known distribution of the *hermannii* Group.

Idiostatus variegatus Caudell (Figs. 16, 25, 58, 90, Plate 6)

Idiostatus variegata Caudell, 1907, pp. 387-388.

Type data. — Holotype female (in Riker mount), three labels. 1. (printed) "Pocatella, Idaho." 2. (printed, red USNM type label) "no. 10186." 3. (handwritten) "*Idiostatus variegata* ANC Caudell."

Type locality. — Pocatello, Bannock County, Idaho.

Deposition of holotype. — The holotype is in the United States National Museum, No. 10,186 ("ANC," refers to Caudell's initials).

Diagnosis. — Size medium for genus, form robust. General coloration variegated yellowish brown or greenish (Plate 6). Males distinctive in following characters: cercus with apex expanded (fig. 25), inner tooth short, stout; titillator (fig. 58) with base rather well developed; styles of subgenital plate short, stout. Females may be recognized by the following combination of characters: tergite ten with shallow V-shaped medium excavation; cercus stout, two and one-half times longer than basal width, straight, apex usually blunt; subgenital plate (fig. 90) with well defined median notch, lobes developed; ovipositor shorter than hind femur, straight. *I. variegatus* is an occupant of the Sagebrush-Steppe community of the northern fringes of the Great Basin (fig. 16).

Species description. — MALE. Size medium, form robust. HEAD. Fastigium of vertex slightly less than half as wide as interocular distance, not well produced dorsally as in the related *I. hermannii* and *I. inermoides.* Eyes not bulging, nearly round, slightly longer dorso-ventrally. First antennal segment three and one-half times broader than second, less than twice as long. PRONOTUM smooth dorsally, appearing punctate on dorso-posterior in some specimens due to color pattern changes in drying. No indication of lateral carinae; median carina indicated only by color or in a few specimens a poorly defined ridge in the posterior one-quarter. Anterior one-fifth of dorsum of pronotum of some specimens transversed by a shallow, undulant sulcus, obsolete in median portion. Anterior margin of lateral lobe of pronotum oblique, ventral margin slightly convex. Posterior margin of lateral lobe of pronotum declivent, slightly concave; in some specimens slightly bowed. APPENDAGES. Legs of normal length, appearing slightly longer than normal for the genus in some specimens. Fore femur armed on anterior margin of ventral surface with one to three minute teeth. Middle femur armed on anterior margin of ventral surface with one to two minute teeth. Posterior femur with scattered short spines, irregular in number on inner and outer margins. Plantula of hind tarsus well defined, one-quarter the length of the metatarsus. ABDOMEN. Dorsum of abdomen smooth in most specimens, some possess indication of median carina but mostly by color. Entire dorsal surface pilose. Dorsum of tergite ten with membranous median portion densely pilose, lateral lobes moderately produced. Cercus (fig. 25). Subgenital plate with median excavation less developed than in *I. hermannii* and *I. inermoides.* Styles shorter, slightly less than the length of one

margin of medial excavation. Styles and external portion of subgenital plate sparsely pilose. Titillators (fig. 58). COLORATION. General coloration typical of the *hermannii* Group. There appears to be a reduced number of green forms perhaps due to the absence of bright green dominant plants such as greasewood which occurs over most of the range of other members of this group. However, this may be somewhat artificial since many of the specimens before me are relatively poorly preserved and the green color may have faded.

FEMALE. Similar to male but with following exceptions: size larger, tegmen protruding slightly beyond pronotum for a distance of less than one-sixth the dorsal length of the pronotum. Tergite ten with shallow V-shaped median incision. Cercus stout, two and one-half times longer than basal width, narrowed to apex which is distinctly blunt but in some specimens with a short finger-like extension. Cercus not decurved or directed inward. Subgenital plate with well defined medial notch with rounded lateral lobes more developed than seen in *I. hermannii* but not acutely pointed as in *I. inermoides*. Ovipositor shorter than posterior femur, straight to slightly recurved, with apical tuberculations both dorsally and laterally, these better developed than in other known species of the *hermannii* Group. Coloration much as in male. Many females possess a black or brown spot dorsally on the abdomen between the tegmina. The ovipositor is a uniform straw brown, sometimes with a greenish cast, with its apex black or dark brown.

Variation. — Although occupying a relatively broad geographic area, little variation has been detected among the specimens before me. This can likely be attributed to the rather uniform low topography of the region occupied by *I. variegatus* (see fig. 16) and the greater probability of panmixis than seen with many of the other species which have populations isolated by physical barriers such as mountains, rivers or deserts.

The greatest degree of variation seems to be that of size among specimens from a single locality.

Seasonal occurrence. — Adults of *I. variegatus* have been taken as early as 19 July and as late as 6 September. Last instars have been collected as early as 28 June and as late as 20 September.

Song. — *I. variegatus* is a diurnal species, the males singing atop sagebrush or *Atriplex* during the day. The song is a continuous low buzz which readily stops and proceeds as short "zics" when disturbed.

Distribution. — *I. variegatus* is a member of the Great Basin community occupying a broad region of the northern portions of this province. Its distribution follows, to a considerable degree, the Sagebrush Steppe community (*Artemisia-Agropyron*) of Küchler (1964). The species occurs primarily in northern Nevada, adjacent Idaho and Utah, and southeast Oregon and possibly north to Washington (fig. 16). Recent records demonstrate its occurrence in Wyoming. No

material of *I. variegatus* is at hand from Washington although there is a single male specimen of the *hermannii* Group from Okanagan, Washington indicating the species group occurs there and it would seem likely that *I. variegatus* might be found in the southern or eastern part of the state.

Records. — COLORADO: MOFFAT COUNTY: Dinosaur Nat'l. Mon., 1.5 mi. W. Harper's Cor., 22 August 1964 (J. Emmel, O. Shields, 3 ♂♂, 5 ♀♀, TJC). IDAHO: ADA COUNTY: Boise, 20 mi. S., 6 September 1923 (C. D. Duncan, 1 ♂, ANSP). BINGHAM COUNTY: no locality, 15 August 1962 (Olson, 1 ♀, UI). Springfield, no date (2 ♀♀, ANSP). BLAINE COUNTY: Bellevue, 9 mi. SW., 24 August 1965 (M. R. Gardner, 1 ♂, UCD). BUTTE COUNTY: Arco, 7 mi. E. at Jct. Hwys. 22 & 20-26, 1 September 1965 (D. C. & K. A. Rentz, 16 ♂♂, DCR). Craters of the Moon Nat'l. Mon., 1 September 1965 (D. J. Horning, 1 ♂, 1 ♀, USNM). GOODING COUNTY: Bliss, 5 mi. N., 19 July 1955 (J. E. Gillaspy, H. W. Smith, 11 ♂♂, 5 ♀♀, 3 last instars ♀♀, UI). Gooding, 6 July 1922, July, 1950 (K. Evans, no other collector, 1 ♂, 1 ♀, ANSP, UI). Tuttle, 7, 8 February 1933 (D. E. Fox, 1 ♂, 1 ♀, USNM). LINCOLN COUNTY: Dietrich Butte, 3 August 1956 (H. W. Smith, 1 ♂, UI). Owynza, 7 August 1955 (J. E. Gillaspy, 3 ♂♂, UI). Shoshone, 2 mi. S., 4,000 ft. elev., 11 August 1956 (J. Rehn, 1 ♀, ANSP). MINIDOKA COUNTY: Rupert, 28 June 1964 (F. Nonini, 1 last instar female, UI). OWYHEE COUNTY: "Stop 14," 8 August 1962 (Wells, Slaughter, 1 ♂, UI). TWIN FALLS COUNTY: Rogerson, 12 mi. SW., 20 July 1961 (W. F. Barr, 1 ♂, UI). OREGON: MALHEUR COUNTY: Adrian, 16 mi. S., 20 September 1967 (K. Goeden, 16 ♂♂, 23 ♀♀, 2 last instar ♂♂, ODA). Huntington, 8 mi. SE., 2,225 ft. elev., 25 July 1941 (J. A. Rehn & J. W. Rehn, 1 ♂, ANSP). UTAH: DAGGETT COUNTY: no locality, 6 February 1939 (W. W. Henderson, 1 ♂, ANSP). JUAB COUNTY: Trout Creek, 24 July 1933 (H. B. Stafford, 1 ♀, ANSP). UINTAH COUNTY: Jensen, 7 September 1932 (C. J. Sorenson, 2 ♂♂, 2 ♀♀, ANSP). WYOMING: CONVERSE COUNTY: Douglas, 26 June 1970 (R. E. Pfadt, 2 ♂♂, last instars, UW). PLATTE COUNTY: Hartville, 5 August 1970 (R. E. Pfadt, 1 ♂, UW).

Specimens studied. — 114, including holotype.

Hosts. — Although restricted to no single host plant, *I. variegatus* is thamnophilous preferring the larger, denser bushes occurring in its range. Where rabbitbrush and sagebrush occur together, as at the Arco locality, the latter was preferred and the coloration of the katydids blended remarkably well with the grey sagebrush.

Discussion. — Although described long ago, *I. variegatus* is not especially common in collections. The largest collection was found in the University of Idaho. However, the relatively small number of specimens does show a broad geographic range for the species. No

additional material from the type locality has come to my attention.

The United States National Museum possesses a single last instar female, pinned but once preserved in alcohol. The specimen is unquestionably this species and is labelled with five labels as follows:

1. (handwritten by Thomas) "*Decticus*? *pallidipalpus*? So. Idaho."
2. (printed) "Collection C. V. Riley."
3. (handwritten) "3."
4. (handwritten) "*Steiroxys pallidipalpus* Thomas A. N. C." This label was in Caudell's handwriting.
5. (printed) red USNM type label with no number written.

It at first appears that this is one of the original specimens used by Thomas (1872) in the description of *Steiroxys pallidipalpus,* the type of which is missing (see Caudell, 1907; Hebard, 1927). The specimen is unquestionably *Idiostatus variegatus* and not a member of the related *Steiroxys.* If this specimen were indeed a part of the original type series, then it would be proper to designate it as lectotype of *S. pallidipalpus* which would become *I. pallidipalpus* with *I. variegatus* entering into synonymy. There is evidence that the single specimen found at the USNM was not a part of the original type series. It does not agree with the original description of *S. pallidipalpus,* differing mainly in the absence of lateral pronotal carinae which are diagnostic in *Steiroxys.* The subgenital plate of the female does not agree with that of the original description. The original Thomas label shows no definite locality in southern Idaho although the Snake River of southern Idaho was given in the original description. The question marks after both *Decticus* and *pallidipalpus* on the Thomas label convincingly demonstrate that he was not certain of the placement of the species. The red USNM type label was likely added much later, perhaps to "flag" the specimen as one of historic note. It therefore seems reasonable to not regard the specimen as a type and to leave the names as they stand. Hebard (1934:54) still convinced that the type of *S. pallidipalpus* was missing, selected Copenhagen, Utah, as the type locality. This was among the original localities listed by Thomas (1872) and the Hebard selection was apparently based on recently collected material, although his statements are confusing in this regard.

In the only collection of *I. variegatus* made by me, I found the

insects restricted to bushes, mostly *Atriplex* sp., although sagebrush was also found in the area. Only three of the ten specimens were greenish, the remainder being light grey or brown. The green specimens were not brilliant in life but rather dull, powdery green which rendered them quite inconspicuous on their host plants which were similarly colored.

The general pattern of coloration of *I. variegatus* is much as described for *I. hermannii*. It was the reticulated pattern of the dorsum of the abdomen which prompted Caudell to give the species its name. *I. variegatus* also differs in coloration from other species in its group in that more specimens possess black banding dorsally on the surface of the abdomen than seen in other species. The tegminal coloration is much as described for those species with indications that the darkening of the larger cells of the tegmina is less intense. This is difficult to ascertain with certainty for the entire range of the species due to the lack of well preserved material for all localities. The black portion of tergite ten is as described for other species in this group with the exception that the median portion (not the soft membranous region) is dark black and the lateral portions of the tergite are brownish. The outer pagina of the hind femur may be uniformly light cream color or possess a light black stripe, the latter condition being more frequent, although both conditions may be observed among specimens from a single locality.

Idiostatus variegatus is most closely related to *I. hermannii* and differs from it in the shape of the cerci of both male and female and the shape of the subgenital plate of the female. Nothing is known of the food preferences but the species is likely to be an omnivorous opportunist, eating animal matter when available but subsisting largely on vegetative matter. *I. variegatus* seems to be very closely associated with the northern Great Basin community and does not venture into the mountainous and forested areas which surround its range.

Idiostatus hermannii (Thomas)

(Figs. 3, 6, 16, 26-28, 59-61; Plates 1, 2, 4)

Steiroxys hermannii Thomas, 1875, p. 904, pl. 44, fig. 4.
Idiostatus hermannii, Scudder, 1894, pp. 181, 183.
Idiostatus hendersoni Hebard, 1939, p. 173, pl. 8, figs. 5, 7. Type locality: Leamington, Utah, July 19, 1918. W. W. Henderson, G. E. King collec-

tors. Type no. 1334, Academy of Natural Sciences of Philadelphia. New Synonymy.

Type data. — Holotype lost as indicated by Caudell (1907:381), confirmed by A. B. Gurney (personal communication). No specimen which could conceivably be considered as original type material was found in any of the collections examined by the author during the course of this study. Much of the Thomas type material of other groups is also lost; he had a notorious disregard for types and it is said that Thomas often joked that types were best destroyed.

Type locality. — No type locality information was given in the original description other than "in the collection of 1873." Thomas (1875:848) mentioned, however, that the collections of "1872, 1873, and 1874 were made in Utah, Nevada, Colorado, New Mexico, and Arizona by Dr. H. C. Yarrow, Dr. J. T. Rothrock, Dr. C. G. Newberry, Lieut. W. L. Marshall, Mr. H. W. Henshaw, and others of the expedition." The expedition refers to the geological surveys of those years. The known geographic range of *I. hermannii* is such that there is little doubt it could have been collected in northwest Colorado, Utah or Nevada. It is not known to occur in New Mexico or Arizona.

Neotype designation. — The loss of the holotype necessitates designation of a neotype to replace it. Since no restricted type locality was given in the description, I hereby designate Rocky Canyon, 7 Troughs Mountains, approximately 35 miles northwest of Lovelock, Pershing County, Nevada, elevation 5,000 feet, as the type locality. A male is selected as the neotype.

Type data. — As noted above and dated 1 July 1969. D. C. Rentz, R. C. Bechtel collectors.

Deposition of neotype. — The neotype is deposited in the California Academy of Sciences, no. 10,486.

Neotype description. — Similar to species description which follows. Neotype of greenish color phase, marked dorsally on pronotum and abdomen with two longitudinal pink stripes. Outer pagina of hind femur without black marking.

Neotype measurements. — Length body 30.50. Pronotum, length 6.50, width 4.60. Length fore femur 5.60, tibia 7.00. Length middle femur 6.80, tibia 8.10. Length hind femur 20.50, tibia 20.40. Length exposed tegmina 4.50.

Diagnosis. — Size medium for genus, form robust. Coloration variegated, often greenish or yellowish with reddish brown hues (Plate 4). Males distinctive in following characters: cercus with simple form, geographically variable,

internal tooth elongate (northern populations) (fig. 27), spine-like, bulbous, tooth reduced (southern populations) (fig. 28); titillator well toothed (figs. 59, 60), arm length variable; styles of subgenital plate short. Females may be identified by the following combination of characters: tergite ten with shallow median excavation; cercus three or four times longer than broad, apex blunt, weakly directed outward; subgenital plate (fig. 91) with well defined median notch; ovipositor shorter than hind femur, with apical tuberculations. *I. hermannii* is an occupant of the Greasewood-Saltbush and Sagebrush Steppe plant communities (Küchler, 1964) of the central portion of the Great Basin (fig. 16).

Species description. — MALE. Size small to moderately large for genus, form slender to moderately robust. HEAD well seated in the pronotum. Fastigium of vertex broad, low, smooth, slightly more than twice as broad as first antennal segment. Eyes large, moderately bulging, dorso-ventrally elongate. First antennal segment broad, fully two and one-half times broader than second, one and one-half longer. PRONOTUM smooth dorsally; some specimens with shallow transverse sulcus on anterior one-fifth, obsolete in median portion of pronotum, not as undulant as in *I. inermis*. Most specimens with no medial carina; a small percentage possess a slight indication of one on posterior one-quarter, others have it indicated only by color. Pronotum without indication of lateral carinae; humeral angle broadly bent, but without carinae. Lateral lobe of pronotum moderately deep; anterior margin straight; posterior margin declivent, slightly concave; ventral margin broadly convex; posterior margin truncate, slightly concave; surface of lateral lobe with indication of posterior sinus. TEGMINA prominent, protruding in normally preserved specimens for a distance of slightly more than half the dorsal length of the pronotum. Veins prominent, net-like on outer margins. APPENDAGES. Legs of normal length, posterior femur protruding for one-quarter its length or more beyond abdominal apex. Posterior femur in most specimens armed on inner and outer ventral margins with several stout spines varying in number from three to eight both individually and on a single specimen. Plantula of hind tarsus slightly more than one-fourth as long as metatarsus. ABDOMEN dorsally smooth but with microscopic shingle-like processes (Plate 2); some specimens with weak indication of dorsal carina, but mostly indicated solely by color. Entire dorsal surface of abdomen pilose, but pilosity more concentrated mesad on tergite ten. Dorsum of tergite ten with soft membranous area clothed with longer dense hairs; lateral lobes (fig. 27) broadly rounded, well developed, apex rather truncate. Cercus (fig. 27). Subgenital plate only half again as long as broad; V-shaped medial incision sharply delimited for a distance of one-fifth the length of the plate itself; styles short, less than half the length of one side of the medial incision. Styles and lateral margins of subgenital plate pilose. Titillators (figs. 59-61). COLORATION very striking, more variable than seen in most other species in the genus with the exception of *I. inermoides*. Most common phase is brown base color with darker brown areas laterally on pronotum and sides of abdomen. Occiput of head usually with dark brown stripe or blotch. Central portion of largest cells of tegmen always dark, often black. Veins light straw

brown. Dorsum of abdomen often with darker brown stripe bounded laterally by two lighter stripes. Outer pagina of hind femur of most specimens without any markings; some specimens have a trace of a black stripe, usually indicated by several black spots. Black present on tergite ten of most specimens, varying from entirely black, except for membranous central portion, to light brown or obsolete in light color specimens.

FEMALE. Similar to male but with following exceptions: size slightly larger; tegmen protruding beyond posterior of pronotum for a distance of up to one-fifth the dorsal length of pronotum. Tergite ten with shallow medial incision. Cercus conical, elongate, three or four times longer than basal width. Apex blunt, pilose, main shaft slightly curved outward at apex. Subgenital plate (fig. 91), slightly upcurved with apical tuberculations. Coloration much as in male with exception that many specimens possess a large black spot between the tegmina. This spot is partially obscured by the pronotum and is present in some males, but obscured by the longer tegmina of that sex. Apical margins and extreme apex of ovipositor black.

Variation. — Variation has been noted in size in the series I have personally collected in 1968 and 1969. The entire collection of 1968 averages much smaller in size than that of 1969. This is apparently a result of the greater amount of food available in the latter year due to the abundant rainfall of the previous winter and increased luxurious vegetation. All of the 1968 specimens are very light colored indicating either that they were from a habitat that was largely sagebrush or that there was little in the way of annual vegetation and the resultant light color phase is an adaptation corresponding with soil color. Perhaps a combination of the two factors is responsible.

The full range of black pigmentation can be seen in series from a single locality. Entire ventral surface pale yellow in specimens of the brown phase. In areas where green plants such as greasewood, *Sarcobatus vermiculatus,* occur, green katydids are more frequently encountered. This color, varying greatly in intensity, replaces the brown of other specimens and seems to be environmentally influenced since it fades when caged individuals are not fed green food.

The data before me at the present time, which are from a rather small number of specimens, show that as one progresses south in the range of *I. hermannii* in central Nevada, there is a change in the length of the inner tooth of the cercus of the male (figs. 26-28). Nevada specimens from Golconda, Imlay, and Buffalo Valley show a reduction in the length of the inner tooth with a corresponding thickening of the shaft of the cercus with its apex more acute and its outer margin straight, not convex (compare figs. 26 & 27). Specimens from Beowawe are typical of the species. A male from Buffalo Valley with a cercus possessing a shortened inner tooth and acute apex, successfully mated several times in the laboratory in 1969 with typical females from Rocky Canyon. The known ultimate extreme in this cline is represented in the material from Dixie Valley, Nevada (fig. 16), with specimens from west of Austin showing similar reduction (fig. 28). Although I have no behavioral data for material from Dixie Valley I believe that mating occurs with more typical examples and

that only a single species is involved. The basic construction of the cercus is not greatly different as one goes south but rather it is a reduction in the length of the inner tooth and elongation of the cercal apex. The angle at which the inner tooth leaves the main shaft is the same in all cases. The southernmost specimens, those from Dixie Valley, approach a bifurcate condition (fig. 28) but the outer portion of the tooth is not involved in copulation and only the inner tooth and the angle at which it leaves the main shaft need be considered.

The Dixie Valley specimens are very similar to most typical *I. hermannii,* with the exception of the characters noted in the description.

Chromosome number. — 2N = 29. A male from 22 mi. N. Winnemucca had the following chromosome complement: 2V + 26R + XV = 29.

EGGS. —Eggs of *I. hermannii* from the Paradise Valley locality agreed with number 45 (light grey brown or light grey red brown) on the ISCC-NBS color chart. Egg measurements, see Table 9. Three captive females from Paradise Valley laid 32, 44, 22 eggs respectively between 8 August and 22 August 1968.

Seasonal occurrence. — *I. hermannii* was collected on 19 July as adults but with many last instar nymphs present (Paradise Valley road, Nevada, 4,400 feet elevation). Later seasonal records for adults are those of 10 September (New Pass Mine, Churchill County, Nevada). A captive male collected as an adult on 1 July 1969 at Rocky Canyon lived, isolated from other individuals in a glass jar, in the laboratory until 20 November 1969 when it died.

Song. — *I. hermannii* sings with a continuous buzz during the day, often several individuals within a single bush stridulating in unison. At night the species elicits short "zics" but these never take the form of the calling song.

Distribution. — *I. hermannii* is rather broadly distributed in the central Great Basin (fig. 16) and inhabits the Greasewood-Sagebrush and Sagebrush Steppe communities. It is known from northwestern Colorado, central Utah, central and northern Nevada and southeastern Oregon. It is likely to be found in adjacent southwestern Idaho, a region of similar vegetation and topography.

Records. — CALIFORNIA: MONO COUNTY: Nevada border, 5 mi. WSW. on Hwy. 167, T3NR28E, 6,700 ft. elev., 8 August 1969 (J. Emmel, O. Shields, 1 ♂, TJC). NEVADA: CHURCHILL COUNTY: Clan Alpine ranch, 1 mi. S., E. slope, Clan Alpine Mtns., T19NR37E, 5,400 ft. elev., 12 July 1969 (J. Emmel, O. Shields, 4 ♂♂, TJC). Fallon, 10 mi. N., 3 August 1966 (G. D. Cooney, 1 ♀, NSDA). New Pass Mine, 10 September 1967 (P. C. Martinelli, 1 ♀, NSDA). Highway 50, 8.5 mi. NE. Jct. Hwy. 50 & 23, N. Eastgate, 5,400 ft. elev., 12 August 1969 (J. Emmel, O. Shields, 1 ♂, TJC). ELKO COUNTY: Elko, 1½ mi. N., 16 July 1968 (C. A. Herlinger, 1 ♀, NSDA). Upper Clover ranch,

31 July 1967, 31 August 1969 (J. R. Earnist, W. J. Lundahl, 1 ♂, 3 ♀♀, NSDA). Fish hatchery, 5 mi. N., Ruby Valley, 8 August 1967 (J. Emmel, O. Shields, 13 ♂♂, TJC). EUREKA COUNTY: Beowawe, 24 July 1969 (J. Burnett, J. D. Peters, 1 ♂, 1 ♀, NSDA); 8 mi. W., 6 July 1967 (J. Emmel, O. Shields, 3 ♂♂, TJC); 56 mi. N. on Hwy. 51, 7 August 1967 (J. Emmel, O. Shields, 5 ♂♂, TJC). HUMBOLDT COUNTY: Near Golconda, 10 August 1945 (W. B. Mabee, 1 ♀, USNM). Hinkey summit, Sta. Rosa Mtns., 7,600 ft. elev., 11 July 1967 (J. Emmel, O. Shields, 1 ♂, TJC). 1 mi. NE. Jct. Hwys. 8B-95, 10 August 1967 (J. Emmel, O. Shields, 4 ♂♂, TJC). Orovada, 12 July 1962, 15 July 1963, 29 August 1963 (J. P. Earnist, W. J. Lundahl, 7 ♂♂, 3 ♀♀, NSDA). 33.5 mi. NW. Jct. Hwys. 95-8A on 8A, 4,700 ft. elev., 19-VII-1968 (D. C. Rentz, 1 ♂, 1 ♀, DCR). Winnemucca, 22 mi. N., 1-12 mi. NE. on Hwy. 8B to Paradise Valley, 4,400 ft. elev. 19-VII-1968 (D. C. Rentz, 23 ♂♂, 50 ♀♀, on road at night, DCR); 4 mi. N., 10 August 1967 (J. Emmel, O. Shields, 5 ♂♂, TJC). LANDER COUNTY: Battle Mtn., 6-8 mi. E., 4,450 ft. elev., 24 August 1941 (J. A. Rehn, J. W. Rehn, 5 ♂♂, 2 ♀♀, ANSP). Bunker Hill, S. slope, 10,000-11,000 ft. elev., 11 July 1969 (J. Emmel, O. Shields, 1 last instar ♀, TJC). Kingston Cyn., E. entr., 5,600 ft. elev., Toiyabe Mtns., 5 August 1967 (J. Emmel, O. Shields, 31 ♂♂, 19 ♀♀, 3 last instar ♀♀, TJC). LYON COUNTY: 3 July 1960 (F. D. Parker, 1 ♀, on *Tetradymia,* NSDA). PERSHING COUNTY: Humboldt Cyn., 10 June, 24 July 1969 (R. C. Bechtel, C. A. Heringer, D. L. Horton, P. C. Martinelli, 3 ♂♂, 9 ♀♀; last instars 1 ♂, 7 ♀♀, NSDA). Imlay, 3 mi. NE., 13 August 1962 (R. C. Bechtel, F. D. Parker, 1 ♂, NSDA); 17 mi. W., 1 August 1967 (D. S. Horning, 3 ♀♀, CDA). Lovelock, 30 mi. E., 19 September 1960 (R. C. Bechtel, 1 ♀, NSDA); 35 mi. NW., 7-Troughs Mtns., Rocky Cyn., 5,000 ft. elev., 1 July 1969 (R. C. Bechtel, D. C. Rentz, 44 ♂♂, 28 ♀♀, DCR, NSDA). Rosebud Cyn., 17 June 1969 (C. A. Heringer, 1 ♂, NSDA). Rye Patch, 21 July 1941 (C. C. Wilson, 1 ♂, 1 ♀, USNM). OREGON: MALHEUR COUNTY: Rome, 3 mi. NW., 13 August 1967 (K. Goeden, 1 ♂, shadscale range, ODA). UTAH: MILLARD COUNTY: Leamington, 19 July 1918 (W. W. Henderson, G. E. King, 2 ♂♂, paratypes *I. hendersoni,* ANSP).

Specimens studied. — 297, including neotype.

Hosts. — Although found in the greasewood-sagebrush community, *I. hermannii* seems to be omnivorous and not restricted to a single plant species. I have personally observed individuals feeding on greasewood during the day and on dead individuals of their own species on roads at night. On 29 July 1969 R. C. Bechtel personally observed *I. hermannii* and *I. elegans* feeding on the dry seed heads of tansy-mustard, *Descurania sophia* (L.) Webb at 5:30 PM in the Rocky Canyon area.

Discussion. — *I. hermannii* has had an interesting taxonomic history. Although the original description by Thomas (1875) appears

clear and applicable only to this species, somehow *I. hermannii* later got confused with *I. californicus*. Scudder (1894) may have begun the discrepancy when he synonymized the two and declared that all of the species of *Idiostatus* were from California and Oregon. This has led to the mistaken idea that type material of *I. hermannii* came from northern California. I have spent much time, with the aid of A. B. Gurney and J. Spohn of the U.S. Department of Agriculture and Smithsonian Institution, respectively, attempting to discover where in California members of the survey of the Territories collected in 1873. All of the study of the logs and notes of the expeditions revealed that they did not get to California in 1873, the year the type was stated to have been collected. They did survey a considerable portion of the range of *I. hermannii,* and the description was rechecked and the statement by Thomas in reference to the cerci is unmistakably *I. hermannii,* "cerci rather short, enlarged at apex, forming a blunt point or angle externally at the tip, while the internal margin of the tip is prolonged into a long, very sharp, and slightly curved spine equal in length to the cerci, thus L, somewhat in the form of an L, being different from any species in this respect that I am acquainted with . . . ."

If Scudder had had material of *I. hermannii* in addition to *I. californicus* he would never have made the error. Although the inner tooth of the cercus of *I. californicus* is somewhat produced (fig. 23), it is never developed as in *I. hermannii*. Hebard (1939) in describing *I. hendersoni,* an obvious synonym, apparently did not read Thomas' original description carefully, which applies to the former with remarkable precision.

I. hermannii is rather scarce in collections of Orthoptera probably owing to its occurrence in areas which have been little collected rather than its rarity in nature. When I have found the species, I always encountered it in large numbers. In the Rocky Canyon collection of 1 July 1969, *I. hermannii* was found together with *I. elegans* and the Mormon cricket, *Anabrus simplex*. The larger *I. elegans* was frequently seen feeding on the smaller, struggling individuals of *I. hermannii*.

I. hermannii is a diurnal species mating from late morning to early afternoon. It is a ground dwelling species venturing frequently into shrubbery but more commonly taken on the ground or in plants

a few inches above the ground. The species, and possibly *I. variegatus* as well, shows aggregating tendencies and mass movement. Populations are not stationary, but during the course of a single season a population may move entirely out of an area in which it would be commonly found at an earlier date. The Rocky Canyon locality illustrated this in 1969. In early July large numbers of both *I. hermannii* and *I. elegans* could be found in the bottom of a small draw leading to the 7 Trough Mountains. The two species together with *Anabrus simplex* and several different grasshoppers were rather concentrated in the bottom of the draw, near the road alongside of which there was abundant green growth of tansy-mustard, *Descurania sophia* (L.) Webb. and shield-cress, *Lipidium perfoliatum* L. The various species were feeding and taking cover in the luxuriant growth. Later in the summer on 29 July the same area was revisited by R. C. Bechtel and P. Martinelli, the former stating that no *Idiostatus* could be found in the area where they had been previously. They had moved to a slightly lower elevation where both *I. hermannii* and *I. elegans* were common together, occasionally in the same bush, of either *Atriplex torreyi* or *Grayia spinosa,* but mostly in the former. He also noted that in one instance the two *Idiostatus* species and the Mormon cricket were found feeding on the seeds of a single individual tansy-mustard plant.

The importance of the specific distinctness of the cerci was aptly demonstrated to me during the summer of 1968. I had begun collecting numbers of this species group in the Denio area of northern Nevada and had made several collecting stops to the south with the largest numbers found on Highway 8B to Surprise Valley. After my return to the laboratory I observed mating behavior but was puzzled after several futile attempts to mate males from Denio with females from Highway 8B. When the reverse was attempted, the results were the same. After four attempts copulation was still not achieved although palpation and copulation was repeatedly attempted. Careful examination of the cerci of the "*I. hermannii*" from the Denio area showed they were indeed different (figs. 26, 29), the Denio representatives proving to be an undescribed species. The two species were morphologically isolated and could not mate.

Males sing with the familiar prolonged buzz during the day, often from a high rock or bush or other prominent perch. A more com-

monly heard call is a short "zic" which is frequently emitted during warm evenings, perhaps to keep the population together. Both sexes wander over the ground at night but mating never occurs at that time. Individuals may be collected in rather large numbers on roads at night where they may be seen feeding on the dead or dying of their own kind or upon other Orthoptera. Females are frequently seen attempting to oviposit in the asphalt surface of the road.

The act of oviposition was observed three times in the laboratory although females readily lay eggs, often late at night. In each case the female made no attempt to grasp weeds, rocks or other objects to tilt her body vertical to the substrate. This in contrast to that as described by Boldyrev (1928) for *Bradyporus multituberculatus* and Snodgrass, in Caudell (1907), for *Peranabrus scabricollis* which are proportionately heavier species. Females of *I. hermannii* merely raise their bodies slightly and bring the ovipositor forward underneath the body and insert it at right angles into the ground to a depth determined by the length of the ovipositor. If the ground is hard, the female uses the alternate sawing movements of the ovipositor valves to insert it into the ground. Often several probes are made until a suitable site is found. Up to four eggs were laid at a single site within one and one-quarter minutes. When finished, the female carefully withdrew the ovipositor and with a few flicking movements of the ovipositor covered the hole. At no time was a female seen to use any part of her body other than her ovipositor to perform this function. In collecting eggs from sand placed with eggbound females, frequently two to four eggs would be found adhering to one another. The eggs are moist when laid and if several are placed together, they adhere loosely. The secretion was never found in sufficient quantity to indicate formation of an ootheca.

The cerci of the male have a proportionately longer inner tooth than seen in any other species in the genus. These needle-like extensions (fig. 27) fit into sockets at the base of the ovipositor during copulation. Dissection reveals that there is no special invagination of the epidermis to receive the cercal teeth but rather they penetrate into the body cavity. Whether they serve merely to hold the female, or to stimulate her is not known. Of note is the observation that females of *I. hermannii* when placed with males of *I. inermoides* always failed to achieve copulation, the former always falling from the backs of the

latter. Greatly hooked cerci would seem to aid in stabilizing the mating pair.

I. hermannii is most closely related to *I. variegatus* from which it can be distinguished by the differently shaped cerci of both sexes and the differently shaped subgenital plate of the female (figs. 90, 91).

Idiostatus inermoides new species (Figs. 16, 29, 62, 92; Plates 1, 2, 6)

Type data. — Three labels, printed. 1. "Nevada; Humboldt Co., 1.5-4.5 mi. W. Denio Jct. on Highway 140, 4,800 feet elevation, 18 July 1968." 2. "D. C. Rentz collector." 3. "Genitalia in permount, solvent toluene."

Type locality. — The exact type locality is located in a greasewood-hopsage flatland just west of the junction of Highways 140 and 8A. The holotype, as with most of the type series, was found on the highway surface after dark.

Deposition of primary types. — The holotype and allotype are deposited in the California Academy of Sciences, no. 10,487.

Diagnosis. — Size medium for genus, form moderately robust. Coloration extremely variable ranging from green with mixtures of reds and browns to golden brown with mixtures of brown and black. Males distinctive in the following characters: cercus with characteristic *I. inermis*-like structure (fig. 29); titillator serrated along arm, usually divergent (fig. 62); apices of femora with genicular spines (see description); black on tergite ten either reduced or moderately developed. Females may be recognized as follows: tegmen with five longitudinal veins; tergite ten broadly incised; cercus three times longer than broad, apex not as blunt as *I. hermannii,* pointed ventrad and inward; ovipositor as long or slightly longer than hind femur, upcurved with scattered tuberculations. *I. inermoides* is an occupant of the greasewood-saltbush plant community of northwestern Nevada (fig. 16).

Description. — HOLOTYPE MALE. Size medium for genus, form moderately robust. HEAD with fastigium of vertex well produced, broad, slightly less than twice as broad as interocular distance. Eyes moderately bulging, more so than in *I. hermannii,* oblong, slightly longer dorso-ventrally; eye slightly more than twice as broad as first antennal segment. First antennal segment broad, three times broader than second; third antennal segment as long or longer than second. Antenna attaining apex of hind femur. PRONOTUM smooth dorsad, slightly convex posteriorly, median carina indicated only by color, if at all; posterior margin of lateral lobe declivent, ventral margin truncate to convex; lateral portions of humeral angles broadly bent, not at all suggestive of lateral carinae; dorsum of anterior one-eighth with shallow, transverse, weakly undulant sulcus, obsolete in median portion; posterior margin of disk truncate to slightly concave.

TEGMINA protruding for a distance of less than one-half the dorsal length of pronotum. APPENDAGES. Legs of normal length for genus. Anterior femur three-quarters the dorsal length of pronotum. Apex of abdomen attaining distal one-fifth of hind femur. Fore femur armed on ventral surface with three small teeth on distal one-third of anterior margin. Middle femur armed on ventral surface with three to four small teeth on anterior margin, a single tooth on posterior margin, these randomly placed. Hind femur armed on ventral surface with five teeth on inner margin, placed mesad; outer margin with four widely spaced teeth. Plantula of hind tarsus short, one-quarter length of metatarsus, elongate, two and one-half times longer than basal width; apex truncate. ABDOMEN dorsally smooth; dorsal surface sparsely pilose; dorsum of tergite ten with soft medial integumental area well indicated, pilose; apex of tergite ten without lobes, undifferentiated. Cercus similar to that of *I. inermis* (fig. 29). Subgenital plate without pilosity. Titillator (fig. 62). COLORATION extremely variable. Holotype basically phaneropterine green with following exceptions: fastigium of vertex and eyes uniformly brown; flagellum of antenna light brown. Pronotum marked dorsally with broad, divergent stripes of brick red, these narrowing at dorsal base of abdomen, becoming two parallel narrow stripes to abdominal apex; lateral lobes creamish to brownish ventrad; posterior margin with ill defined bowed region of creamish yellow, this continuous to ventral portion and onto anterior margin. Tegmen with veins very light straw brown contrasting with light brown cells, the innermost portions of which are much darker than the outer. Abdominal tergite ten straw brown except for basal mesal portions which is slightly infuscated, this extending somewhat laterad but not forming a ring in holotype. Cercus uniformly straw brown, the teeth darker apically. Entire ventral surface, including subgenital plate, light green. All legs uniformly phaneropterine green, the proximal portions of tibia straw brown, of each femur darker brown. All spines brown distad, the base and mesal portions straw brown, a medial dorsal dark brown stripe extending from base to apex. Calcars straw brown, apical one-fourth dark brown to black. All femoral teeth uniformly jet black. Plantula straw brown, extreme apex darker brown.

Holotype measurements. — Length: body, 21.00; pronotum, 5.60 × 3.60; fore femur, 4.40; tibia, 5.00; middle femur, 5.20; tibia, 6.50; hind femur, 26.10; tibia, 27.00; exposed tegmina, 2.60.

ALLOTYPE FEMALE. Similar to male but with following exceptions: size moderately larger but somewhat shrunken in drying; tegmen protruding from beneath pronotum for a distance of one-sixth dorsal length of pronotum; tegmen with veins well indicated, five longitudinal veins extending from base to apex, the others reticulate. Tergite ten rather broadly incised. Cercus elongate, not as in *I. hermannii,* more than three times longer than broad, apex rather blunt, but with narrow tip, distinctly decurved and directed inward. Subgenital plate (fig. 92) with median notch more shallow than in *I. hermannii.* Ovipositor longer than hind femur, upcurved, apex with scattered tuberculations. Coloration golden brown dorsally from vertex to abdominal apex. Head uni-

formly straw brown except at posterior dorsum of eye which is blackish. Eye uniform reddish brown. Flagellum of antenna darker brown. Lateral lobes of pronotum black except at posterior margin which is creamish, bowed anteriorad; disk golden except mesal portion which is longitudinally striped black. Medial portion of abdomen with irregular herringbone V-shaped black stripes. Tergites eight, nine, ten marked laterad with black. Cercus brown, apex darker brown. Tegmen straw brown, the tiny cells between the heavy veins somewhat darker. Legs uniformly light straw brown except hind femur which is black spotted dorsally at base, the outer pagina with indistinct dark brown longitudinal stripe, this composed of spots, the medial group coalesced forming a quadrate area; inner pagina infuscate; apex of hind femur with darker brown, weakly defined annulus. Ovipositor uniformly straw brown except on dorsal surface at base which is dark brown for a distance of one-fifth length of appendage; extreme apex black tipped. Entire ventral surface of insect light straw brown.

Allotype measurements. — Length: body (slightly shrunken due to drying), 20.50; pronotum, 6.30 × 3.00; fore femur, 5.30; tibia, 6.50; middle femur, 6.20; tibia, 7.60; hind femur, 18.50; tibia, 17.70; ovipositor, 20.10; exposed tegmen, 1.30.

Variation. — More than the normal amount of morphological and chromatic variation is apparent in the small series before me. Some individuals of either sex show weak indication of a median carina on the dorsum of the abdomen. The structure of the cercus with regard to the length of the teeth is also variable, but not to the extent that it affects intraspecific mating. Color shows the greatest degree of variability, almost every specimen in the series before me being differently marked from every other. The pleasing combination of color and pattern ranks this species among the most handsome of all the western Decticinae.

The basic herringbone or variegated pattern of the dorsum of the abdomen is retained in each specimen (Plate 6) but the base color and perimeter of the darker markings may be intensified by additional hues of brown or red. Darker specimens, brown phases, may possess a black stripe on the outer surface of the hind femur; this may be reduced to a series of spots in lighter specimens or may be absent as with most greenish specimens. Some of the darker brown phase specimens have dark brown or black spots on the sides of the abdomen. Most males, and some females, possess a black or at least a dark brown ring on the basal portion of tergite ten, this better developed basad in median portion.

EGGS. — The eggs from females in the type series agreed with number 60 (light grey brown) in the ISCC-NBS color chart. See Table 9 for measurements.

Derivation of name. — The name refers to the cerci which resemble those of *I. inermis* in structure.

Seasonal occurrence. — Not enough information is available to indicate the exact seasonal occurrence of *I. inermoides,* but the species likely resembles its relatives *I. hermannii* and *I. variegatus* in this regard.

Distribution. — *I. inermoides* is known only from the alkali flats near Denio, Nevada. The species likely extends north into Oregon in similar situations which are indicated by Küchler (1964). To the south along Highway 140, the species was either absent or "replaced" by *I. hermannii* (fig. 16). Single males from Okanogan, Washington, and Smith, Nevada, may represent this species. These specimens are further discussed in the section Unplaced Specimens.

Records. — NEVADA: HUMBOLDT COUNTY: 1.5-4.5 mi. W. Denio Jct. on Hwy. 140, 4,500 ft. elev., 18 July 1968 (D. C. Rentz, 10 ♂♂, 12 ♀♀, holotype, allotype, paratypes, CAS, DCR); 18 mi. W., 17 June 1962 (R. R. Snelling, 1 last instar ♀, CIS).

Specimens studied. — 22.

Hosts. — The type series was collected in a flat area vegetated largely by greasewood with a smaller number of widely scattered salt-bush plants. Many katydids could be found in the greasewood both at night and especially during the day when they sought cover from the intense sunlight. At night most of the katydids left the bushes and within an hour after sunset many could be found wandering about on the desert floor and highway, feeding and singing.

Discussion. — The discovery of this distinctive species came as a surprise during my search for *I. bechteli* in northern Nevada in 1968. Although rather abundant at the type locality, the katydids were found hiding in the dense greasewood and salt-bush vegetation during the day and were most difficult to collect at this time. Almost all of the type series was taken at night between 9:30 PM and midnight (PDST) on the surface of the highway. As with other members of the genus, *I. inermoides,* though diurnal with regard to mating, ventures forth at night to feed and oviposit. The species was not uncommon in the area of the type locality, but a fraction of a mile either side of the area delimited as the type locality (1.5-4.5 mi. W. Denio Jct., Nevada) was void of the species. This indicated to me that the species of the *hermannii* Group are concentrated, as well as species in the *elegans* Group.

Of biogeographic interest is the proximity of two other species of the *hermannii* Group (fig. 16). It seems likely that *I. inermoides* must come into contact with *I. variegatus* in the north and *I. hermannii* to the south but this is still not certain. In the laboratory, males of *I. inermoides* failed to achieve copulation with females of

I. hermannii collected 22 mi. N. Winnemucca, Nevada. The reciprocal cross also failed. The lack of success is attributed to the difference in structure of the male cerci and corresponding female subgenital plate (figs. 26, 29, 91, 92). The pairs of both crosses attempted repeatedly to achieve copulation but physical coition was not possible. This demonstrates once again that the cerci and subgenital plate are effective isolating mechanisms, although all of these experiments were performed under laboratory conditions.

The *inermis* Group

The *inermis* Group (*I. rehni, I. inermis, I. major*) contains probably the best known representative of the genus, *I. inermis.* This species is widespread over the western portion of the Great Basin and is frequently encountered by general collectors. It is often abundant enough to be of economic importance. Only three species are included within the group and all are diurnal, thamnophilous and xerophytic.

The overall appearance of species in the *inermis* Group is distinctive (Plate 7). The pronotum is usually bicolored, the anterior three-quarters usually dark brown, the distal one-quarter usually lighter reddish brown. The abdomen is usually unicolorous dark brown often with white flecks arranged laterally forming an indistinct longitudinal stripe. The distal portion of the abdomen is usually well ringed with black. Green forms comprise a small percentage of the populations of *I. inermis* and *I. rehni,* but are unknown in *I. major.* Structurally the titillator of the male shows no development of the base in any of the species and the teeth are usually arranged along the outer margin of the flattened arm.

Mating in the *inermis* Group is always diurnal and the spermatophore is dumbbell-shaped. Hybridization is known for *I. inermis* and *I. rehni* but has not been detected in the sympatric and closely related *I. major* and *I. inermis.*

Idiostatus rehni Caudell (Figs. 17, 30, 31, 63, 93, Plates 1, 7)

Idiostatus rehni Caudell, 1907, p. 382, fig. 70.
Idiostatus rehni, Caudell and Hebard, 1912, p. 167. Lectotype designation: "the figured male."

Type data. — Two specimens, male and female, together in Riker

FIG. 17. — Known distribution of the *inermis* Group.

mount. Male the lectotype, five labels. 1. (printed) "Siskiyou Co., Cal." 2. (printed) "A. Koebele collector." 3. (printed red USNM type label) "no. 10184." 4. (handwritten) "Idiostatus rehni ♂ type Caud., Idiostatus rehni ♀ type Caud." 5. (handwritten) "Idiostatus sp. see 0-1-3, p. 181." This latter reference is to Caudell's filing system which lists Scudder's 1894 work on page 181 where an undescribed species was mentioned.

Type locality. — Siskiyou County, California. No further site information is available.

Deposition of lectotype. — The lectotype is in the U.S. National Museum, No. 10,184.

Diagnosis. — Size moderate for species group, form moderately robust. Coloration greyish or greenish in life, pronotum usually bicolored (fig. 93), anterior three-quarters dark brown, distal one-quarter reddish brown. Males distinctive in following characters: median portion of tergite ten soft, sparsely pilose, lobes acute (figs. 30, 31); cercus dorso-ventrally flattened, expanded apicad, teeth not greatly produced; titillator (fig. 63) without base, toothed along entire outer margin, arm elongate. Females may be identified by the following combination of characters; tergite ten deeply incised mesad; cercus conical straight, five times longer than basal width; subgenital plate (fig. 93) as long as broad, incised to one-quarter its length.

I. rehni is an occupant of the Montane Chaparral community of north central California and southern Oregon (fig. 17).

Species description. — MALE. Size medium for genus, form not greatly robust. HEAD with fastigium of vertex half as broad as interocular distance, lateral sulcation at base well developed. Eyes moderately bulging, dorso-ventrally elongate, three times longer than width of first antennal segment. First antennal segment three times broader than second, slightly more than twice as long. PRONOTUM smooth dorsad, median carina slightly indicated on posterior one-quarter of a small number of specimens; posterior one-half of disk laterally rounded forming distinct shoulder, without indication of carinae; shallow transverse carina indicated dorsally in anterior one-fifth; posterior margin of lateral lobe declivent; ventral margin sloping dorsad anteriorly. APPENDAGES. Legs of normal length for genus, hind femur protruding at least one-quarter its length beyond apex of abdomen. Fore femur usually without teeth on anterior ventral surface. Middle femur without teeth on anterior ventral surface. Hind tibia armed dorsally with 21 spines on outer margin; inner margin with 24 spines, the proximal spines short, tooth-like; ventral surface seven to eight spines on outer margin, inner margin with seven spines. Plantula of hind tarsus one-third length of metatarsus, narrowed basad, expanded apicad. Hind femur armed on both margins of ventral surface with up to ten small teeth. ABDOMEN dorsally smooth, without indication of median carina.

Dorsum of tergite ten with soft integumental median area; lateral margins slightly produced forming short, truncate projections (figs. 30, 31); soft integumental portion sparsely pilose, lacking in some specimens altogether. Cercus (fig. 63). Subgenital plate half again longer than broad, V-shaped median excavation one-quarter length of plate; styles short, less than two-thirds as long as margin of one side of medial incision. Style and margins of subgenital plate pilose. Titillator (fig. 93). COLORATION. General color pattern very similar to that of *I. inermis*. Most common phase grey brown. Head, legs, sides of abdomen mottled grey brown with scattered white flecks. Pronotum dark brown, distal one-quarter often reddish brown; lateral lobes with humeral angles dark brown or black; posterior and ventral margin of lateral lobe with light yellow border. Tegmina reddish brown. Abdomen dorsally with broad black markings on distal portions of terga. Legs usually without black markings, but in a small percentage of dark specimens with small blackish area at base of hind femur; never a black stripe on outer pagina. Abdominal tergites eight, nine, ten ringed with black; dorsal medial portions often brown as other parts of abdomen. Soft integumental portion of dorsum of tergite ten yellow brown or straw brown. Dorsum of abdomen usually with white flecks forming two parallel longitudinal stripes from tegminal apices to apex of abdomen; some specimens have the internal area bounded by the stripes lighter brown or reddish brown. A small percentage of a population contains pale, straw brown specimens without much color at all. Green specimens comprise 35-40 percent of population. These differ in having head and pronotum (posterior one-quarter often light brown near shoulders); legs and abdomen dorsally and ventrally green. Tegmina reddish or straw brown; no black on tergites eight, nine, ten; tergite ten and cercus entirely unicolorous light straw brown. White flecks on abdomen as above. Cerci of all specimens with teeth black tipped. All spines with apices black, teeth uniformly black.

FEMALE. Similar to male but with following exceptions: size larger, tegmen protruding beyond pronotum for a distance of less than one-quarter the dorsal length. Tergite ten deeply incised mesad producing two lateral lobes with apices acute. Cercus conical, nearly straight, pilose, five times longer than basal width. Subgenital plate as long as broad, incised mesad for a distance of one-quarter its length. Ovipositor longer than hind femur, with tuberculations on dorsal and lateral margins of distal portions. Coloration as described for male with exception that green females have not been found.

Variation. — There is considerable variation in the development of the apical tooth of the cercus of the male among specimens from the locality near Weed, California. Some show considerable development of this structure, others lack it completely. This may be due to introgression or backcrossing with hybrids of this species and *I. inermis*. This is discussed more fully in the next section of this paper. A single male labelled Yreka, California, is fully twice the size of the others in the series but structurally similar.

Chromosome number. — 2N = 29. A male from ten miles north of Weed, California, had the following chromosome complement: 2V + 26R + XV = 29.

EGGS. — Eggs of the single female collected ten mi. N. Weed, California, agreed with number 22 (red grey) on the ISCC-NBS color chart. Measurements in Table 9.

Seasonal occurrence. — The earliest adult was taken on 29 June and the latest known specimen was recorded 3 September.

Song. — *I. rehni* sings during the day with a continuous buzz which is slowed to short "zics" when disturbed (Plate 1). This is an extremely wary species and very difficult to approach without being detected.

Distribution. — *I. rehni* is known from a few scattered localities in Siskiyou County, California, and adjacent southern Oregon (fig. 17). The species is associated with the Montane Chaparral community, Küchler (1964), and is most commonly found on rabbitbrush.

Records. — CALIFORNIA: SISKIYOU COUNTY: Ball Mtn., 7,700 ft. elev., 3 September 1968 (K. Goeden, A. Gurney, 1 ♂, 2 ♀♀, ODA, USNM). Jct. Hwy. 97 & Military Pass road, 2 mi. E., 27 July 1965 (D. C. & K. A. Rentz, 5 ♂♂, DCR). Weed, 29 June 1935 (N. W. Graves, 1 ♂, USNM); 10 mi. N. on Hwy. 97 at A12 (to Yreka), 27 August 1965 (D. C. Rentz, 11 ♂♂, 2 ♀♀, DCR); 27 July 1968 (D. C. & K. A. Rentz, 9 ♂♂, DCR). Yreka, 9 October 1941 (H. W. Graves, 1 ♂, CAS). Siskiyou County, no definite locality (A. Koebele, 1 ♂, paratype, ANSP); same (1 ♂, CAS). OREGON: JACKSON COUNTY: Siskiyou, 3 mi. W., 1 September 1968 (L. Gentner, K. Goeden, A. Gurney, 1 ♂, USNM).

Specimens studied. — 37, including lectotpye and lecto-allotype.

Hosts. — I have found *I. rehni* in low-growing rabbit-brush, *Chrysothamnus* sp., and big sagebrush, *Artemisia tridentata* with the former apparently preferred.

Discussion. — *I. rehni* is a little known species of north central California and adjacent southern Oregon. It is apparently almost identical in its biology with that of its relative *I. inermis*. The two species are sympatric and synchronic in the region ten miles north of Weed, California. Hybridization between the species is discussed in the next section of this paper.

I. rehni is apparently sporadic in its annual occurrence, the species not being found in the same locality year after year. This is not uncommon in this genus, but its relative, *I. inermis*, does not behave in this manner. Efforts to determine the precise geographical limits of the species were rendered more difficult by this aspect of the life cycle. Collecting in the Yreka vicinity failed to yield any representatives of

the species even though there is a single record of a much larger than normal specimen from that area.

Hybridization Between I. Inermis and I. Rehni

Although *I. inermis* and *I. rehni* are as strongly differentiated as are any of the species in the genus (compare figs. 31-33) they are related members of the same species group and overlap in a portion of their range. It is of interest that a possible hybrid has been detected in the zone of overlap indicating probable gene flow between the two species. The single specimen, a male, was collected in 1965 in Siskiyou County, California, two miles east of the junction of Military Pass road and Highway 97. At the time of that collection examples of both species were found as well as *I. californicus.* Both members of the *inermis* Group were found on or near the ground in low bushes but the latter was ecologically separated in higher chaparral. As discussed in the Variation section of that species, *I. inermis* is peculiar in the northwesterly limits of its range (Siskiyou County and adjacent southern Oregon) in the elongate, spatulate condition of its titillator. The cerci of both *I. inermis* and *I. rehni* seem sufficiently distinct to preclude hybridization, but careful examination of specimens from that locality demonstrates that the internal tooth of the cercus is very similar in shape, size and angle from the main shaft in both species. The very elongate apical tooth in *I. inermis* would seem to aid the grasping ability in a cross involving males of the latter species. I have observed matings of *I. inermis* and the apical tooth of the cercus of the male is not inserted into any modification of the subgenital plate of the female, but rather rests externally near the base of that appendage and seemingly aid in firmly grasping the female. No female hybrids have been recognized possibly due to the overall morphological similarity of the two species.

One can hypothesize that males of *I. inermis* would be more likely to cross with females of *I. rehni* than the reverse cross due to the stabilizing effect of the apical tooth of the cercus in males of the former. This tooth is reduced to the point of being non-functional in *I. rehni* rendering the chances less for males of this species to be successful with females of *I. inermis.* It seems likely that some backcrossing must also be occurring in the populations but this has not yet been recognized.

The putative hybrid male is intermediate in characteristics of the genital complex (compare figs. 31, 33 with fig. 32). Other attributes such as color, size, length of tegmen and appendages are so similar between the two species that differences are not detectable in the hybrid. Spination of the dorsal surfaces of the fore and middle tibiae of both species is 0-3, 2-4, typical of all species in the *inermis* Group. The hybrid, however, possesses a single spine more on the posterior margin of the left foreleg; the middle tibia on that side has five instead of two spines on the anterior dorsal margin. The hybrid is intermediate in the development of the pilosity of the dorsal surface of the abdomen. This character is pronounced in *I. inermis* and lacking in *I. rehni;* the hybrid is sparsely pilose to a degree not yet found in either of the presumed parents.

Idiostatus inermis (Scudder) (Figs. 17, 33, 64, 65, 94; Plates 1, 7)

Cacopteris inermis Scudder, 1899, p. 89.
Cacopteris nevadensis Scudder, 1899, p. 91. (Female only.)
Idiostatus inermis Caudell, 1907, p. 386.
Cacopteris inermis, Rehn and Hebard, 1920, p. 251.
Idiostatus inermis, Hebard, 1934, p. 45.

Type data. — Described from a series of two males and three females stated in Scudder's original description as coming from the vicinity of Lake Tahoe, Nevada, September, W. H. Henshaw, Lt. Wheeler's exploration of 1876. Lectotype here designated; male, labelled "Wheeler Exp. 1876, 170, Cacopteris inermis Scudder's type 1899."

Type locality. — The type locality is stated to be "in mountains near Lake Tahoe, Nevada." See discussion for further comments.

Deposition of lectotype. — The lectotype is in the Museum of Comparative Zoology, Harvard University, No. 14,148.

Diagnosis. — Size medium for genus, form moderately robust. Coloration brownish or greyish, pronotum bicolored (Plate 7); green forms encountered in small percentage of population. Males distinctive in following characters: tergite ten with soft mesal area, densely pilose, lateral lobes broadly rounded (fig. 33); cercus bifurcate, juncture of teeth often excavate; titillator (fig. 64) without base, arm serrated on outer margin for entire length, northwestern populations spatulate (fig. 65). Females may be identified by the following combination of characters: cercus conical, broad in basal one-half, narrowed to apex which is acute, directed inward; tegmen usually with two longitudinal veins con-

tinuous from base to apex; ovipositor straight, tuberculate laterally and dorsally.

I. inermis is an inhabitant of the Juniper-Steppe Woodland and Great Basin Sagebrush plant communities (fig. 15).

Species description. — MALE. Size medium to small for genus, form robust. HEAD with fastigium of vertex slightly more than half as wide as interocular distance, moderately produced dorsad, broadly rounded. Eyes moderately to slightly bulging, slightly dorso-ventrally elongate, three times broader than width of first antennal segment. Frons and genae with widely scattered pits. First antennal segment three times broader than second, two and one-half times longer. PRONOTUM smooth dorsally, some specimens with indication of median carina on posterior one-quarter; posterior margin of lateral lobe declivent, ventral margin straight to convex; posterior one-third of humeral angle bent suggesting lateral carinae; shallow undulant transverse sulcus weakly indicated on anterior one-sixth. APPENDAGES. Legs of normal length, hind femur protruding at least one-half its length beyond apex of abdomen. Plantula of hind tarsus small, less than one-quarter length of metatarsus, broad basad, but nearly twice as long as basal width, apex obtuse. ABDOMEN dorsally smooth, without indication of median carina. Entire dorsal surface of abdomen pilose. Dorsum of tergite ten with membranous median area, densely pilose, lateral lobes broadly rounded (fig. 33). Cercus (fig. 33). Subgenital plate almost twice as long as broad, V-shaped median incision sharply delimited for a distance greater than one-quarter the length of plate itself; style long, at least as long as length of one side of incision. Styles and margins of subgenital plate sparsely pilose. Titillator (fig. 64). COLORATION. General color grey brown, the brown usually very dark. White area of pronotum always limited to posterior border of lateral lobe, rarely along ventral margin. Pronotum rarely with posterior dorsal portion reddish brown as in *I. rehni,* usually more unicolorous. Tegmina reddish brown to light straw brown. Fore and middle legs usually without black markings, possessing only a mottled somewhat herring-bone pattern of brown. Outer pagina of middle and hind femur with a few black spots dorso-laterally, never forming a stripe. Abdomen with black marking laterally on the distal portion of each tergite, this usually reduced or absent in green or pale brown specimens. Abdominal tergites eight, nine, ten always with black markings, the latter segment being entirely black except for membranous area and lateral area adjacent which is reddish brown. Abdomen marked dorsally with white flecks forming an indistinct longitudinal stripe on each side of dorsal surface. Tegminal apices never white as described for *I. rehni.* A small number of specimens possess a broad stripe of light brown dorsally on pronotum and abdomen. Cercus reddish brown, apices of teeth black.

FEMALE. Similar to male but with following exceptions: size slightly larger, tegmen protruding beyond apex of pronotum for a distance of approximately one-quarter the dorsal length of disk, usually with two prominent longitudinal veins continuous from base to apex. Tergite ten appearing to be deeply incised in some dried specimens. Cercus conical, three and one-quarter times longer than basal width, pilose, broad in basal half, abruptly narrowed to apex

which is acute and directed inward. Subgenital plate slightly broader than long, with small median incision for a depth of less than one-fifth length of plate. Ovipositor straight, apical one-quarter tuberculate laterally and dorsally. Coloration as described for male.

Variation. — Tinkham (1944:323) gave the impression that *I. inermis* is primarily a greenish colored species. In over 350 specimens seen in this study, only four of each sex were found to be green. The predominant color of this species is greyish brown, this darkening as the individual ages. Green seems to be under edaphic control, tending to appear in those individuals found in more verdant situations.

The most obvious variation of *I. inermis* is that of size. Certain populations are considerably larger than others. In attempting to determine such trends a geographical sorting shows the southernmost representative to be the largest, those of the Reno, Nevada, and eastern California areas (Table 7). Those to the north are smaller. Similarly populations from higher elevations (Sheep Mountain, California, 11,000 feet) are smaller than those of lower elevations (Peavine Mountain, Nevada, 5,000 feet). It can be hypothesized that the growing season is shorter at the higher elevations, and the katydids spend less time in nymphal instars and sacrifice size for rapid growth.

Individual variation is considerable with regard to the width and spatulation or excavation of the large tooth of the cercus. At any given locality one may find individuals possessing a cylindrical tooth which is moderately expanded basad; others may have a rather stout tooth abruptly narrowed apically; a third group may show a concave region in the basal portion of the large cercal tooth where it meets the main shaft of the cercus. In most specimens, including the lectotype, the entire dorsal surface of this ventral tooth is concave.

All of the specimens from Hat Creek and Siskiyou County, California, as well as adjacent southern Oregon have the titillators as depicted in fig. 65. The arm is more elongate, teeth laterad and the arm is spoon-shaped or concave distally giving the apex a broadly recurved appearance. The base of the arm is also slightly more developed. The normal, or most commonly encountered condition (fig. 64), shows a rather short arm, cylindrical rather than flattened, with teeth arranged dorsally. The base is very little, if at all, developed, typical of the specimens from Emerson Peak, Modoc County, California. No katydids which could be considered intermediate in this condition have been detected from critical localities. Plumas and Lassen County specimens are typical of the species. Females show no apparent geographic variation.

Chromosome number. — $2N = 29$. A male from Peavine Peak, Nevada, had the following complement: $2V + 26R + XR = 29$.

EGGS. — Eggs of a captive female from Emerson Peak, California, compared well with number 60 (light grey brown) on the ISCC-NBS color chart. Two females from Stead Air Force base near Reno, Nevada, laid 196 and 181 eggs respectively between 9 July and 18 September 1969 when they died. Both had been collected as adults. Two females from Emerson Peak, also collected as adults, laid 51 and 99 eggs respectively from the time of their capture on

5 September and their deaths on 30 September and 31 October 1969. Eggs measurements: Table 9.

Seasonal occurrence. — Adults of *I. inermis* were collected as early as 3 July (male) and as late as 29 October (both sexes). One male labelled Wentworth Pass, California, is dated 11 June 1961. If accurate, this is the earliest known record for an adult. The emergence of nymphs is greatly dependent upon the time of local melt (early records) and first freezing weather in autumn (late records). The late records for the species were made at Peavine Peak, near Reno, Nevada, and is of interest because the observations were made prior to the first hard frosts of 1969. Bechtel (personal communication) notes that males were actively singing although they were somewhat sluggish and darkened in color.

Song. — *I. inermis* sings during the day with a continuous buzz, often several individuals in a single bush singing in unison. The species slows to a "zic" pattern (Plate 1) when disturbed and frequently emits such "zics" at night.

Distribution. — *I. inermis* is known from many localities in the western Great Basin (fig. 15) at elevations ranging from 4,000 to 11,000 feet. It is an inhabitant of the Juniper Steppe Woodland and Great Basin Sagebrush plant communities.

Records. — CALIFORNIA: ALPINE COUNTY: Markleeville, 8 August 1963 (G. Harmon, 1 last instar ♀, CDA, ex: meadows sweeping). Woodfords, 9 September 1965 (D. C. Rentz, J. D. Birchim, 4 ♂♂, 2 ♀♀, DCR). Near Woodfords Cyn., W. Fork Carson River, 11 August 1951 (J. G. Rehn, 1 ♀, ANSP). INYO COUNTY: Big Pine, 10 mi. W. at Sage Flat Camp, 28 July 1968 (D. C. Rentz, 1 ♂, DCR). Glacier Lodge, 1 mi. E., no date (E. L. Sleeper, 1 ♂, CSLB). LASSEN COUNTY: Doyle, 1 mi. N., 4,200 ft. elev., 6 September 1969 (D. C. Rentz, 1 ♂, DCR). Facht, 12 September 1921 (no collector, 2 ♂♂, 3 ♀♀, ANSP). Hallelujah Jct., 13 July 1949 (F. Morishita, 1 ♂, 1 ♀, CIS); 12 July 1962 (R. M. Bohart, E. J. Montgomery, E. L. Westcott, 3 ♂♂, LACM, USD); 2 July 1964 (D. F. Veirs, 5 ♂♂, CIS); 23 July 1966 (D. C. & K. A. Rentz, 4 ♂♂, DCR). Litchfield, 31.8 mi. N. on Hwy. 395, 6 September 1969 (D. C. Rentz, 1 ♂, DCR). MODOC COUNTY: Emerson Peak, 8,900 ft. elev., 25 mi. E. Likely, 5 September 1969 (G. Buxton, K. Goeden, A. Gurney, D. Rentz, 8 ♂♂, 7 ♀♀, CDA, ODA, DCR, USNM). MONO COUNTY: Blanco's Corral, White Mts., 10,150 ft. elev., 25 August 1960 (D. Q. Cavagnaro, C. A. Toschi, 6 ♂♂, CIS, JRH). Coleville, 6 mi. N., Slinkard Cyn., 24 June 1962 (C. D. MacNeill, 1 ♀, DCR). Convict Lk., 2 mi. E., 23 July 1962 (D. C. Rentz, 3 ♂♂, 1 ♀, 1 last instar ♀, DCR). Lee Vining, 3 mi. N., 6,400 ft. elev.,

24 August 1957 (T. J. Cohn, E. R. Tinkham, 1 ♂, 1 ♀, UM); 8 mi. S., 25 August 1957 (E. R. Tinkham, 1 ♀, UM); 10 mi. N., 13 August 1961 (D. C. Rentz, 1 ♂, DCR). Lee Crk., 11 August 1953 (H. P. Chandler, 1 ♀, CAS). Lee Vining vic., 6,000 ft. elev., September 1969 (H. F. Rowell, 1 ♂, CIS). Mammoth Lake, 29 July 1940 (D. E. Hardy, 3 ♂♂, 2 ♀♀, ANSP, UK). Mono Inn, 0.5 mi. S. at So. Cal. Edison Sta., 2 August 1968 (J. Emmel, O. Shields, 1 ♂, 1 ♀, TJC). Monitor Pass, 1 mi. E., 8 September 1964 (J. S. Buckett, M. R. Gardner, 7 ♂♂, 3 ♀♀, UCD). Mono Lk., 10 mi. N. Lee Vining, 6 August, 9 August 1961 (D. C. Rentz, 6 ♂♂, DCR); 28 July 1962 (D. C. Rentz, 2 ♂♂, 1 ♀, DCR). Pickle Mdw., 11 August 1960 (R. R. Montanucci, 1 ♂, UCD). Sheep Mtn., 11,000 ft. elev., 6 September 1964 (J. S. Buckett, M. R. Gardner, 22 ♂♂, UCD). Silver Lk., 15 August 1957 (R. Casebeer, 1 ♂, LACM). Tom's Place, 9 mi. W. at Rudy Lk., July 1968 (C. D. MacNeill, 1 last instar ♂, DCR). PLACER COUNTY: Donner Peak, 26 September 1964 (F. L. Blanc, 2 ♂♂, 6 ♀♀, CDA); 1 mi. S., 14 July 1966 (F. L. Blanc, 1 ♂, CDA). Squaw Peak, 8,300-8,900 ft. elev., no date (1 last instar ♀, ANSP). Sugar Bowl, 20 September 1967 (M. R. Gardner, 21 ♂♂, 6 ♀♀, UCD). PLUMAS COUNTY: Beckwourth Pass, 10 July 1962 (T. R. Haig, 1 ♀, 1 last instar ♀, CDA); 29 August 1963 (T. R. Haig, 1 ♀, CDA). Chester, 18 August 1919 (T. D. Urbahns, 1 ♂, last instar ♂♂, USNM). Harkness Peak, 8,000-9,200 ft. elev. (J. Rehn, M. Hebard, 1 ♂, 2 ♀♀, 1 last instar ♀, ANSP). Spencer Lks., 20 August 1961 (M. R. & R. C. Gardner, 1 ♂, 1 ♀, UCD). Johnsville, 9 mi. S., road to Spencer Lks., 8 September 1959 (J. S. Buckett, 1 ♂, ex: *Chrysothamnus nauseosus,* UCD); 8 mi. N., Spencer Lks. road, 10 July, 9 September 1961 (J. S. Buckett, M. R. Gardner, 18 ♂♂, 9 ♀♀; 1 ♂, 5 ♂♂ last instars, UCD). SIERRA COUNTY: Sattley, 30 July 1969 (W. E. Ferguson, 7 ♂♂, 1 ♀, SJSC). Sagehen, Little Truckee Riv., 8 mi. N., 27 July 1956 (E. G. Linsley, 1 ♀, ex: *Chrysothamnus,* CIS). Yuba Pass, 2 October 1962 (T. R. Haig, 1 ♀, CDA). SISKIYOU COUNTY: Bartle, 10 mi. N., 18 September 1964 (G. M. Buxton, A. B. Gurney, 5 ♂♂, 7 ♀♀, CDA). Dorris, 31 July 1969 (R. P. Allen, G. Kusick, 1 ♂, CDA, prey of wasp *Sphex ichneumoneus* (Linn.)). Jct. Hwy. 97 & Military Pass rd., 2 mi. E., 27 July 1965 (D. C. & K. A. Rentz, 8 ♂♂, 1 ♀, DCR). Tule Lk., 8 August 1928 (C. C. Wilson, 2 ♂♂, USNM). Montague, no further data (1 ♀, USNM). County unknown: Lassen Nat'l Park, 9 September 1941 (E. C. Van Dyke, 1 ♀, CDA). NEVADA: DOUGLAS COUNTY: Gardnerville, 15 mi. S., 21 July 1962 (E. J. Montgomery, 1 ♂, UCD). Minden, 24 June 1931 (C. C. Wilson, 1 ♂, 3 ♀♀, CDA, USNM). LANDER COUNTY: Kingston Cyn., 15 mi. S. Hwy. 50, 8 mi. E. Hwy. 8A, 4 September 1957 (R. A. Belmont, 1 ♀, CDA). LYON COUNTY: Smith, 3 July 1960 (F. D. Parker, 1 ♂, ex: *Tetradymia,* NSDA). ORMSBY COUNTY: no further data, July (1 ♂, 2 ♀♀, ANSP). Baker, 6 July (1 ♂, 4 ♀♀, ANSP, USNM). Carson City, 1 mi. SW., 4,900 ft. elev., 17 July 1969 (J. Emmel, O. Shields, 5 ♂♂, 3 ♀♀, TJC). STOREY COUNTY: Virginia City, 29 July 1931 (E. R. Tinkham, 7 ♂♂, 4 ♀♀, ANSP). WASHOE COUNTY: Cold Sprs., Lawton Vy. (Reno), 11 July 1946 (I. La Rivers, 1 ♀, UR). Red Rock, 6 August 1962 (R. C.

Bechtel, F. D. Parker, 19 ♂♂, 18 ♀♀, ex: *Chrysothamnus viscidiflorus*, NSDA). Reno, 2 September 1910 (J. G. Lamiman, 3 ♂♂, 1 ♀, ANSP, USNM); 7 September 1938 (I. La Rivers, 1 ♀, UR); 9 June 1940 (I. La Rivers, 2 ♀♀, UR); 6 May 1940 (I. La Rivers, 1 ♂, UR); 9 August 1940 (I. La Rivers, 1 ♂, UR); nr. Stead airforce base, 11 August 1967 (D. C. & K. A. Rentz, 14 ♂♂, 1 ♀, ex: desert plum, DCR); 9 July 1969 (D. C. Rentz, W. W. Middlekauff, 8 ♂♂, 12 ♀♀, DCR). Sun Valley, 13 June 1968 (C. A. Heringer, 1 ♀, NSDA); Slide Peak, Sierra Nevada south to Washoe Co., 5,500-8,500 ft. elev., 6 September 1910 (2 ♂♂, 1 ♀, ANSP). Steamboat, 1.5 mi. W., 4,800 ft. elev., 16 July 1969 (R. C. Bechtel, 1 ♂, NSDA). Thomas Crk. nr. Reno, 31 July 1958 (W. E. Simonds, 2 ♂♂, 3 ♀♀, CDA). Peavine Mtn., south slope, 29 October 1969 (R. C. Bechtel, J. R. Adams, F. D. Parker, 3 ♂♂, 3 ♀♀, NSDA). OREGON: KLAMATH COUNTY: Tule Lake, 17 September 1928 (L. P. Rockwood, 1 ♀, USNM). Beatty, 1 mi. E., 21 August 1970 (K. Goeden, 1 ♂, 1 ♀, ex: *Chrysothamnus*, ODA). Merrill, 4 mi. WSW., 21 August 1970 (K. Goeden, 1 ♂, 1 ♀, ex: *Chrysothamnus*, ODA).

Specimens studied. — 369, including lectotype.

Hosts. — *I. inermis* is a thamnophilous species inhabiting the Sagebrush community of the western portion of the Great Basin and is found most commonly on sagebrush and rabbitbrush. Desert peach, bitterbrush and other small shrubs may also harbor this species.

Discussion. — *I. inermis* is one of the most widespread and commonly collected species in the genus. It occurs at a wide range of elevations and is tolerant of a rather broad range of climatic conditions.

An attempt was made, by reference to old reports, to determine with more precision the exact type locality. There are several reports of survey activities of the Corps of Engineers in the Tahoe area during 1876 but the most likely survey on which the type series was collected is that described in the report of Macomb *in* Wheeler (1877:1278-1284). Several surveys were made which included the area of concern (mountains near Lake Tahoe, Nevada), but the trip led by Lt. Macomb is apparently the only one to the apparent type locality in which W. H. Henshaw, the collector, took part. No mention is made of the katydids or of any other insects in Macomb's report. The party was in the general area of the type locality as stated in Scudder (1899) on 24 September 1876 and according to Macomb *in* Wheeler (*ibid.*: 1280) the main party including Henshaw was left at Zephyr Cove (southeast Lake Tahoe) while Lt. Macomb and a topographer went elsewhere for two days. Scudder lists "Sept." as the collecting date in his paper and it seems likely the type series was collected at this

time, perhaps in the Genoa Peak area to the east. Specimens are known from near this locality (Virginia City and Steamboat, Nevada).

I. inermis can be of economic concern in years of high populations. The Cooperative Economic Insect Report (1962:845) lists *Idiostatus* sp. (most likely *inermis*) occurring at densities of 3-5 adults per *Chrysothamnus nauseosus* plant over a five mile area at Red Rock Canyon, Washoe County, Nevada. That same publication (1963: 903) listed *I. inermis* in abundance along the highway with lighter populations present in a 10-12 mile area from Sod House to the junction of Highways 8A and 95 in Humboldt County, Nevada. The locality data lead me to believe that the species concerned was *I. hermannii,* not *I. inermis.* In 1964 that publication (1964:101) recorded a moderate infestation of *Idiostatus* species on rangeland in August in southwestern Washoe County, Nevada.

This species is usually found singly but in years of high population numbers, colonies or groups of individuals such as described above may be frequently encountered. A group of males may sing in unison, this attracting members of both sexes and concentrating the population. A single shrub may harbor 30-40 of the insects while a similar adjacent plant may not harbor a single individual.

Idiostatus major Caudell, new status (Figs. 17, 34, 66, 95, Plate 7)

Idiostatus inermis major Caudell, 1934, p. 153, fig. 5 (new variety).

Type data. — Three labels, type pinned. 1. (handwritten) "Lassen Co., Calif., July 1930, from F. H. Wymore." 2. (printed red USNM type label) "no. 44907." 3. (handwritten) "*Idiostatus* ♂ *inermis* var. *major,* holotype Caudell."

Type locality. — The type locality is located on U.S. Highway 395 in southeast Lassen County, California. No further information is available concerning the precise locality where the type was taken.

Deposition of primary types. — The holotype and allotype are deposited in the U.S. National Museum, No. 44,907.

Diagnosis. — Size medium for genus, large for *inermis* Group, form robust. Coloration almost exactly as described for both *I. inermis* and *I. rehni* except that no green forms are known. Males distinctive in following characters: dorsum of tergite ten with V-shaped medial incision, the lobes acute; cercus with peculiar development of internal tooth (fig. 34), which originates from main shaft almost at its base; titillator with distal two-thirds flat, broad, with

small serrations along entire length, apex distinctly truncate. Females may be identified by the following: cercus conical, apex directed inward; subgenital plate as long as broad, incised for one-quarter its length; ovipositor longer than hind femur, straight, serrated on both margins. *I. major* is an occupant of the Chaparral community of the extreme western limits of the Great Basin (fig. 17).

Species description. — MALE. Size medium for genus, form robust. HEAD with fastigium of vertex produced ventrad, low, broad. Eye low, dorso-ventrally produced ventrad, apex directed inward, two and one-quarter times longer than first antennal segment. First antennal segment fully three times broader than second, twice as long. Third antennal segment one and one-half times longer than second. PRONOTUM dorsally undulant, lateral shoulders abruptly bent in posterior one-third; anterior one-fifth of disk with shallow, well defined, undulant sulcus, obsolete in median portion, continuous to dorsal portion of lateral lobe; median portion of disk, depressed; median carina not well indicated except in posterior one-third where it is slightly better defined; anterior margin of disk concave, posterior margin truncate. Anterior dorsal margin of lateral lobe of pronotum straight; ventral margin broadly obtuse; posterior margin declivent, concave mesad; surface of lateral lobe smooth, polished in dorso-lateral region of humeral angle. TEGMINA protruding beyond apex of pronotum for a distance of half the length of pronotum. APPENDAGES. Plantula of hind tarsus well developed, half again as long as basal width, one-third length of metatarsus. Proximal tarsal segment equal in length to second. Hind femur unarmed or with up to four short irregularly placed teeth. ABDOMEN without dorsal carina, if indicated, then only by color; dorsal surface moderately smooth, not polished, without pilosity. Median portion of tergite ten soft, membranous, V-shaped, densely clothed with long pile; lobes formed by median incision, truncate apically. No other abdominal tergites specially modified. Cercus (fig. 34). Subgenital plate subcarinate in region of styles; median incision prominent, V-shaped for a depth of one-fifth of plate itself; style elongate, as long or slightly longer than length of one side of median incision. Titillator (fig. 66). COLORATION. Nearly identical with that described for *I. inermis* except green forms are unknown.

Holotype measurements. — From Caudell (1934:153). Length: body, 27.00; pronotum, 7.00; hind femur, 21.00; exposed tegmen, 4.00.

FEMALE. Similar to male but with following exceptions: size larger, abdomen more robust. Tegmen protruding beyond apex of pronotum for a distance of up to one-third dorsal length of pronotum; tegmen with six to seven veins running longitudinally along entire length, few if any cross veins. Tergite ten with V-shaped medial incision for a distance of less than half the length of the segment. Cercus conical, stout, slightly twice as long as basal width; greatest width in median one-third, apex narrow, finger-like, directed inward or straight; surface densely pilose, each seta emanating from a tuberculate sensory structure. Subgenital plate (fig. 95), longer than basal width. Ovipositor longer than hind femur, straight, sparsely tuberculate on apical one-fifth only; dorsal valve tuberculate in apical one-fourth; ventral valve without tuberculation or with

feeble indication of such; apex not sharply defined. Coloration much as in male. Ovipositor greyish except at extreme apex in region of tubercles where it is dark brown, tip black; tubercles light brown, contrasting with grey of ovipositor.

Allotype measurements. — From Caudell (1934:153). Length: body, 26.00; pronotum, 6.50; hind femur, 23.00; exposed tegmen, 2.50; ovipositor, 26.00.

Variation. — No significant morphological variation has been noted among the small series of available specimens. The coloration is quite constant and is as described for *I. inermis,* except no green individuals have been encountered.

Seasonal occurrence. — Due to the poor representation of *I. major* in collections, an accurate picture of its seasonal appearance is not possible now.

Distribution. — *I. major* is known only from the east slopes of the Diamond Mountains in Lassen County, California (fig. 17).

Records. — CALIFORNIA: LASSEN COUNTY: Doyle, July 1930 (F. H. Wymore, 2 ♂♂, 1 ♀, holotype, allotype, USNM); 16 July 1952 (R. W. Harper, 1 ♀, CDA); 6 September 1963 (M. W. Wasbauer, 15 ♂♂, 7 ♀♀, on *Chrysothamnus nauseosus* var. *occidentalis* Hall, CDA); 23 July 1966 (D. C. & K. A. Rentz, 1 ♂, 1 ♀, DCR). Milford, 9 mi. N. on Hwy. 395, 4,300 ft. elev., 6 September 1969 (D. C. Rentz, 5 ♂♂, 2 ♀♀, on sagebrush and rabbitbrush, DCR).

Specimens studied. — 31, including holotype and allotype.

Hosts. — M. S. Wasbauer of the California State Department of Agriculture, Bureau of Entomology, found large numbers of individuals during the day on the flowers of rabbitbrush, *Chrysothamnus nauseosus* var. *occidentalis* Hall. I have since found them in the same situation but also on big sagebrush, *Artemisia tridentata,* and bitterbrush, *Purshia tridentata.* Specimens were more numerous in the rabbitbrush which was in full bloom at the Milford, California, locality. Five individuals feeding on the flowers were observed.

Discussion. — Caudell (1934) proposed *I. major* as a variety of *I. inermis* stating ". . . the strikingly different cerci as compared with those of *inermis* seem to warrant the varietal name *major* above proposed." There is little doubt that this species is closely related to *I. inermis* but there is no evidence of geographic isolation and there is an indication that the two species are sympatric. Without clear evidence of geographical separation, there is no reason to consider the two as subspecies. As discussed below, the two are best regarded as distinct species.

On 9 September 1969 I placed a male *I. major* collected nine

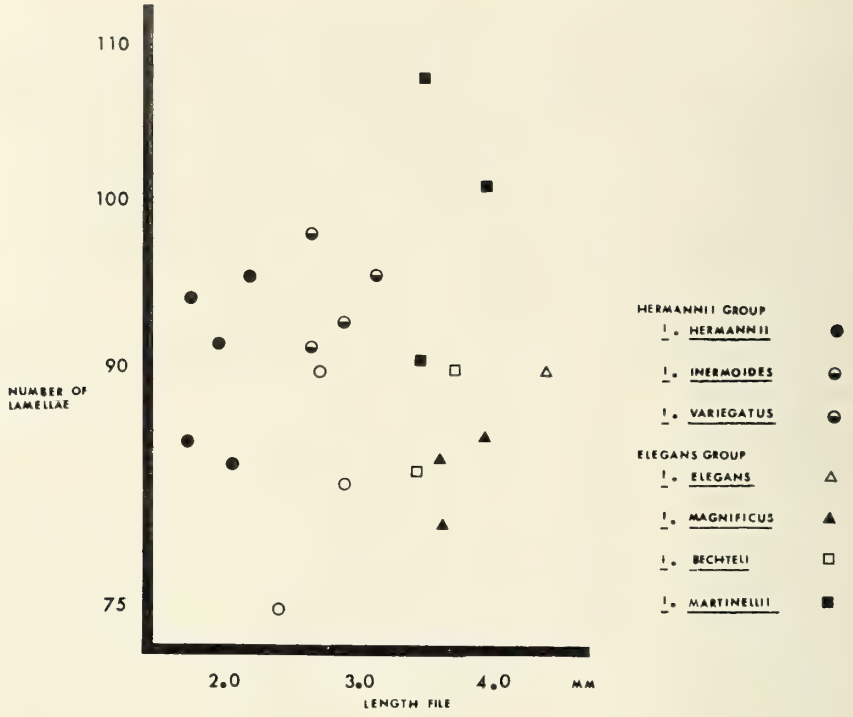
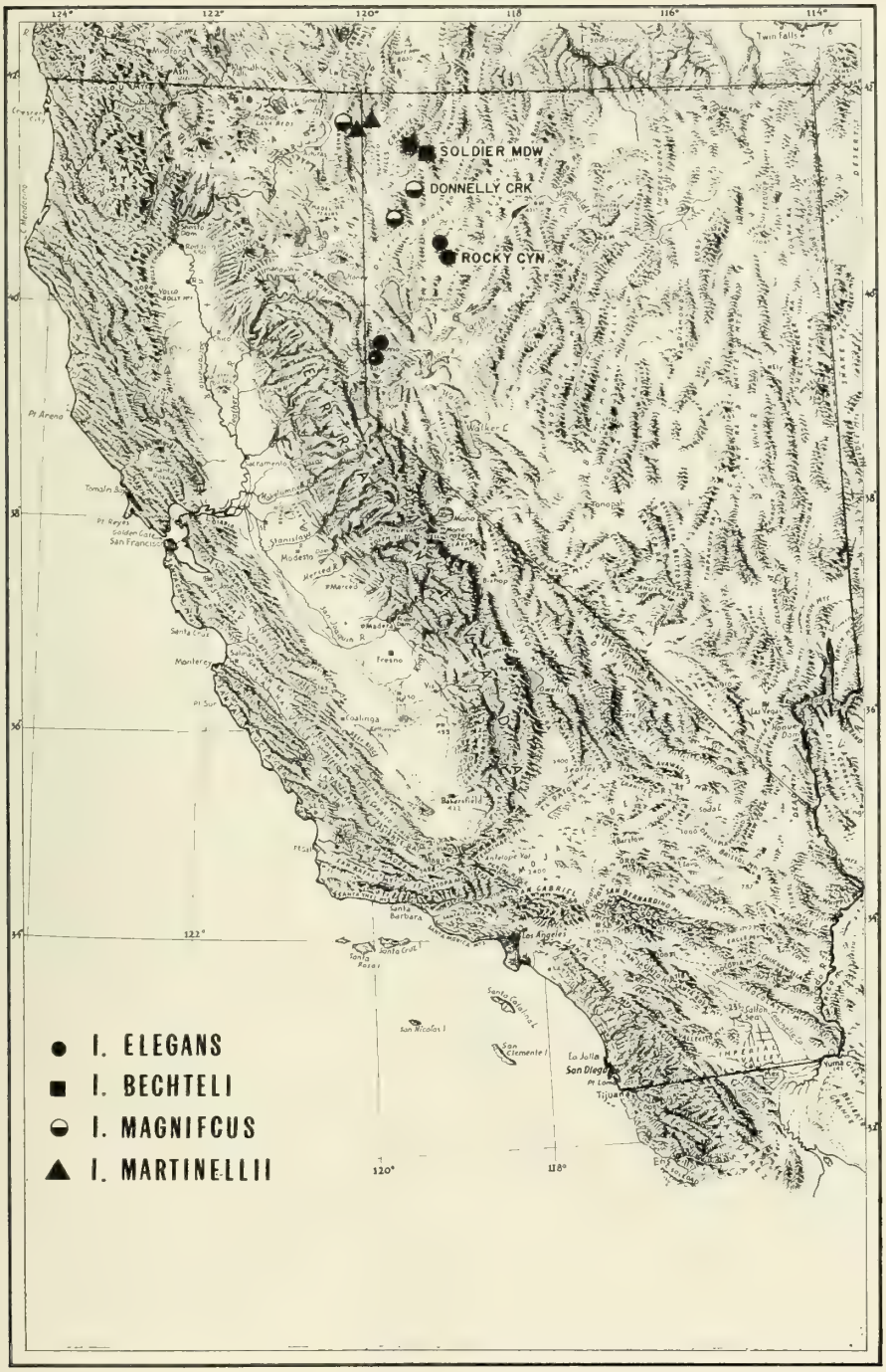


TABLE 4. — Scatter diagram of lamella number plotted against file length for left male stridulatory file.

miles north of Milford, California, on the observing platform (see introductory remarks on courtship observations) with a female of *I. inermis* from Emerson Peak, Modoc County, California. Repeated attempts at copulation were noted but mating was apparently unsuccessful due to the difference in genitalic structure. The reciprocal combination was observed, utilizing different individuals from the same localities and copulation was achieved and a spermatophore passed. However, two hours later the spermatophore fell from the female and was devoured by her. Whether sperm could penetrate into the spermatheca in this time is not known but in normal condition the spermatophore remains attached for at least 24 hours, in some instances even longer. This indicates that it must take considerable time for the contents of the spermatophore to be properly absorbed. I thus conclude that the above mating was likely unsuccessful.

FIG. 18. — Known distribution of the *elegans* Group.


SOLDIER MDW
DONNELLY CRK
ROCKY CYN
I. ELEGANS
I. BECHTELI
I. MAGNIFICUS
I. MARTINELLII

When I have encountered *I. major* in the field I have always found it associated with dense chaparral vegetation. The vegetation of the eastern slopes of the Diamond Mountains, along Highway 395, in eastern California is quite lush, noticeably greener and more dense than that to the north or east along the same highway. In 1969 I located *I. major* only in the region nine miles north of Milford, California. This area was densely vegetated with big sagebrush and rabbitbrush, with many forbs and grasses in lush growth. Diptera, Hymenoptera, Lepidoptera as well as several species of grasshoppers and crickets were found in abundance. At 1:00 PM (PDST) many *I. major* adults were found, some bushes harboring six or more very wary katydids. At a distance of 15 feet a singing male would slow the pattern of his call or cease it altogether, scurry down the plant and often seek refuge in the litter at the base. Over 50 individuals of *I. major* were observed at that locality in an area of less than an acre. Mating was occurring at this time as indicated by three females which were bearing fresh spermatophores. Actual copulation was not observed in the field.

To the north (31.8 miles north of Litchfield, California) and to the south (Doyle, California, the type locality) *I. major* was not found in 1969, the habitat being considerably drier. At both of the above localities only *I. inermis* was found, at the latter spot the katydids were almost solely restricted to spiny desert peach, *Prunus andersonii* Gray. North of Litchfield only a single individual, a male, was found in bunchgrass in a formerly burned area.

Observations made in 1966 and 1969 suggest that *I. major* requires a distinctly greener habitat than *I. inermis* which occupies a wide variety of conditions both ecologically and altitudinally. *I. major* may be outcompeted by *I. inermis* in the drier portion of its range but able to successfully compete with it under more "favorable" conditions. With the inconsistent and localized climatic pattern found in northeastern California and adjacent Nevada, local conditions may vary considerably from year to year. Where *I. major* might be abundant one year, it might be absent in succeeding ones until greener conditions return. As indicated in the introduction to this paper, the eggs of several species of *Idiostatus* likely diapause for several years. This would help to explain the disjunct nature of the distribution of both *I. inermis* and *I. major* in the eastern portion of the Diamond Mountains and the adjacent desert during a given season.

The *elegans* Group

Members of the *elegans* Group (*I. magnificus, I. elegans, I. bechteli, I. martinellii*) are large, robust ground-dwelling inhabitants of the Great Basin biome and are usually associated with the Greasewood-Saltbush plant community. The robust nature of the abdomen (Plate 8) usually restricts the insects in their ventures into shrubbery. The four included species are very similar in overall appearance, the abdomen usually uniform slate grey and striped only in a single species (*I. bechteli*). Green individuals are known only in that species. On the basis of the shape of the cercus of the male *I. elegans* and *I. magnificus* are closely related as are *I. bechteli* and *I. martinellii.* On this same basis, *I. magnificus* appears to be the primitive member of the group, showing the least degree of specialization in this character. *I. bechteli* and *I. martinellii* are much more specialized in this respect, the latter species likely the most specialized of the group in this characteristic.

All are diurnal although feeding and wandering occurs at night. A characteristic of this group is the localized nature of populations and the mass movement or banding tendencies of such populations. A single population may be completely absent from an area which had been well populated by the same species a few weeks earlier. There is evidence (see introduction) indicating long diapause for eggs of species of the *elegans* Group and mass emergence after a period of absence for several years. It appears that weather plays a key role in determining this emergence.

Observations of *I. elegans* in the field indicate that it is more carnivorous than many other species of the genus. *I. martinellii* also shows these tendencies as noted by observation of individuals on roads at night. Mating occurs only during the day, usually during mid to late morning hours. A horizontal substrate is required.

Members of the *elegans* Group are characterized in having the distal abdominal segments intensely black, the mesal portion of tergite ten yellowish or pinkish, soft, pilose; the distal lobes of tergite ten are soft, broadly rounded. The titillator of all species but the primitive

I. magnificus (and here only a portion of the population) have pronounced basal callosities in the membrane at the base of the arms (figs. 67-69). The pronotum is most often bicolored, the anterior three-quarters light grey, the distal one-quarter pinkish or brownish; the tegmina are reddish brown. Females have a characteristic ovipositor with few or no tuberculations, these indicated mostly by color; the valves are evenly pointed, the apex somewhat blunt. The subgenital plate of the females of the species of this group are distinctly modified (figs. 96-99).

Idiostatus magnificus Hebard (Figs. 5, 7, 18, 35, 36, 67; Plates 1, 8)

Idiostatus magnificus Hebard, 1934, p. 46, pl. 2, fig. 4; pl. 3, fig. 6.

Type data. — Two labels. 1. (printed) "Cedar Peak, Warner Mts., Cal., summit 8,000-8,400 ft., 25 August 1922 (R & H)." 2. (handwritten) "Idiostatus magnificus Hebard, Type 1240."

Type locality. — The type locality is adjacent to California State Highway 299 which transects the Warner Mountains. The handwritten fieldnotes of Mr. Hebard indicate more precisely the details of the original collections: "Hudsonian zone but sagebrush still present. Rock strewn slopes, areas of short dry yellow grasses and a variety of low plants of the Hudsonian Zone. Locally a few fox-tail pines . . . Decticid RARE 1 ♂ R [R refers to Rehn as collector] on bare rock fragments at base of lava pinnacle, 8,200 ft." Refer to discussion for additional comments on the type locality.

Deposition of holotype. — The holotype is in the Academy of Natural Sciences of Philadelphia, No. 1,240.

Diagnosis. — Size large, form robust. Coloration in life usually grey, becoming reddish brown in museum specimens. Distal portion of each abdominal segment whitish giving the insect a ringed appearance. No longitudinal striping; green overcast present only on a single specimen. Males distinctive in following characters: middle tibia conspicuously swollen proximad, laterally compressed; cercus (fig. 35) convex, bulbous apically, inner tooth produced; titillator (fig. 67) with or without basal callosities. Females may be identified by the following combination of characters: four or five longitudinal veins on tegmen, the inner pair parallel, outer veins bowed laterad; tergite nine with weak median incision, tergite ten deeply incised; cercus elongate, conical, broadest in basal one-quarter, gradually narrowed to apex; subgenital plate (fig. 96); ovipositor straight, slightly longer than hind femur, tuberculate, without dorsal serrations.

I. magnificus is an occupant of the Greasewood-Saltbush plant community

of northwestern Nevada and adjacent California (fig. 18). The type data indicate the species also occurs in the Coniferous Belt of the Warner Mountains, California.

Description. — HOLOTYPE MALE. (Redescribed because of its distinct nature; see notes following species description.) Size moderate for genus, small for species group, form robust. HEAD with fastigium of vertex low, broad, in height even with first antennal segment. Eyes large, flattened, dorso-ventrally elongate, the portion adjacent to the antenna straight. Frons and genae mostly smooth with widely scattered shallow pits. First antennal segment broad, fully three times broader than second, distinctly less broad. Antenna of holotype not entire. PRONOTUM appearing smooth, but micro granulose, not polished; anterior one-fifth of dorsum of disk with shallow, undulant, transverse sulcus, obsolete in median portion; median surface of disk with shallow, undulant V-shaped sulcus, accentuated mostly by color, the sulcus more deeply indicated mesad; median carina indicated only by color, obsolete in distal one-half. Postero-lateral angles of pronotum broadly rounded, no indication of carinae; anterior margin of disk straight, posterior margin of lateral lobe concave mesad, ventral margin truncate; surface of lateral lobe smooth. TEGMINA protruding beyond apex of pronotum for a distance of one-half dorsal length of disk, veins prominent, median cells large, without accessory veins; outer cells small, the veins net-like. Left tegmen with left margin undulant, concave mesad, right margin produced anteriorad. APPENDAGES. Legs appearing of normal length for genus, apex of abdomen attaining apical five-sixths of hind femur. Middle tibia slightly but not greatly swollen mesad, without longitudinal sulcus. Outer surface of distal one-fifth of hind tibia with sulcus indicated only by color. Fore tibia unarmed dorsally on anterior margin, posterior margin with three equally spaced spines; ventral surface armed with six spines on anterior and posterior margins, the proximal three spines separated from each other by a three-fold greater distance than that separating the distal trio of spines. Fore femur armed on anterior margin of ventral surface with two stout, recurved teeth, these positioned in distal one-third of femur. Middle tibia armed dorsally with two spines on anterior margin, four spines on posterior margin; ventral surface armed with six to seven spines on anterior and posterior margins. Middle femur armed on distal one-third of posterior margin of ventral surface with a single, stout, recurved tooth. Hind tibia armed dorsally on both margins with 21 closely spaced teeth of nearly equal length mesad, of decreasing length distad and proximad; ventral surface with seven widely spaced spines. Hind tibia armed with two dorsal apical spurs, the innermost spur subequal in length to outer spur; dorsal surface of each of inner pair of spurs greatly concave in apical one-half, the basal one-half stout, thickened. Plantula of hind tarsus short, one-third length of metatarsus, apex broadly acute. Proximal tarsal segment not greatly produced, equal in length to next two segments combined. Hind femur armed on ventral surface with five stout, uncinate teeth, these positioned on apical one-half of leg. Surface of hind femur with short, stout setae.

ABDOMEN with weak indication of median carina on distal one-third of each tergite, this accentuated due to black coloration. Dorsal surface of abdomen with micro granular structure, sparsely clothed with long pile. Median portion of abdominal tergites nine and ten specially modified. Tergite nine depressed mesad, this region membranous, pilose. Tergite ten with broader modification, occupying fully one-half of dorsal aspect of tergites; surface of medial area with scattered tuberculae, sparsely pilose, apex little produced, lateromedial angles broadly rounded. Median incision of tergite nine short, broad. Cercus (figs. 35, 36) with main shaft not swollen basad, of equal length from base to region of internal tooth where it is swollen; apical one-third bulbous, especially in inner apical region; inner margin concave forming a broad angle with inner tooth which is directed inward and slightly downward; outer margin broadly obtuse, the apex of cercus with a distinct toe or acute projection, directed inward. Entire cercus clothed with stout setae. Subgenital plate subcarinate in region of style; median incision broadly V-shaped for a distance of one-quarter to one-half length of plate; style short, one-third as long as length of one side of medial incision. Surface of subgenital plate mostly glabrous, a few scattered setae on outer margin. Titillator (fig. 67) without basal callosities. COLORATION. General overall coloration grey-brown. Head light greyish brown ventrad of eyes. Antenna dark reddish brown throughout except first segment which is greyish. Eye mottled grey brown without ring. Area from base of eye dorsad to vertex jet black. Fastigium of vertex tan or reddish brown. Pronotum greyish mesad and along anterior margin and anterior and posterior margin of lateral lobe. Posterior border of disk of pronotum reddish brown. Remaining portions of pronotum black or reddish brown. Tegmen uniform reddish brown, the veins lighter than membranes. Prosternum and other thoracic sternites without any indication of black markings. Dorsal surface of fore tibia light brown except at base of spines where it is dark brown or black. Anterior surface of all tibiae with faint brown longitudinal stripe in apical one-quarter of leg. Fore and middle femora greyish marked dorsad with several black spots. Hind femur greyish, heavily marked in dorsal proximal region with many coalesced broad, transverse stripes forming an elongate blotch. Mesad on hind femur on both inner and outer surfaces is a black, short blotch, separated from the main black region at base of femur by a distance of at least twice the length of blotch itself. Ventral margin of hind femur black in region of teeth. Distal portion of hind femur with brown apical annulus. All spines of legs brown or black in basal portion except proximal spines of hind tibia which are uniform brown. Dorsal surface of most spines with narrow continuous brown stripe from base to apex which is either dark brown or black. Medial region of each spine light brown. Tarsi light brown dorsally, darker ventrally, especially in distal region. Plantula of hind tarsus uniform dark brown. Abdomen dorsally marked with black as shown (fig. 35), the other portions greyish. Dorsum of abdominal segments eight, nine, ten jet black except for medial region of segments nine and ten which is light brown. Proximal medial region of abdominal

segment eight brown across entire portion of segment. Pile of segments nine and ten white, sockets of setae of tergite nine brown. Cercus uniformly light reddish brown, with pink overcast. Inner tooth of cercus brown basad, this becoming darker at apex. Setae of cercus light brown. Subgenital plate uniformly greyish brown. Abdominal sternites each with a small ovate spot on each side.

Holotype measurements. — Length: body, 24.00; pronotum, 6.70 × 5.00; fore femur, 5.29; tibia, 6.30; middle femur, 6.40; tibia, 7.10; hind femur, 15.50; tibia, 17.10; exposed tegmen, 3.80.

Species description. — MALE. Differs from holotype in following characters: size larger, fully twice as large as holotype, form robust. Head similar, vertex not as produced. Pronotum with meso-caudal depressed region, surface smooth, with micro granulae, not polished. Middle tibia distinctly swollen proximad, laterally compressed. Fore, middle and hind tibia with longitudinal sulcus indicated mostly by color. Abdomen basically as described. Cercus similar but with some variation (see next section). Titillator of most specimens with basal callosities. Species coloration vastly different from that described for holotype. Head as described. Disk of pronotum reddish brown, rarely black except in region of ventral V-shaped sulci. Lateral lobes of pronotum darker mesad, whitish on posterior margin. Caudal one-third of disk of pronotum contrastingly lighter, straw brown in some specimens. Thorax with three black markings laterad. Femora and tibia marked as described except ground color and black marking somewhat more extensive. Apical one-fifth of hind femur marked on dorsal surface with elongate black stripe. Basic ground color of all tibia in life aquamarine, this fading to greyish or brownish in poorly preserved specimens. Femora similarly colored but with more grey in life. Tarsi pink in life, fading to straw brown, darker ventrad. Abdomen uniformly grey in life, fading to reddish brown in death. Distal margin of each segment whitish, rendering abdomen ringed in appearance. Median portion of abdominal tergites nine and ten pink in life becoming reddish brown after death. Subgenital plate cream color, contrasting with cercus.

FEMALE. Similar to male but with following exceptions: size slightly larger, abdomen more robust. Tegmen protruding beyond apex of pronotum for a distance of slightly less than one-third dorsal length of pronotum. Median veins of tegmen heavy, extending from base to apex, four to five in number the inner pair parallel, the outer veins bowed laterad. Internal longitudinal veins usually without cross veins. Lateral one-quarter of tegmen with small, indistinct veins; latero-medial one-quarter of tegmen with heavier veins, net-like, the resultant cells quadrate or ovoid. Medio-lateral veins not as heavily developed as longitudinal veins. Tergite nine with only slight modification distad, this represented by a broad, undulant, shallow concavity. Tergite ten deeply incised for almost its entire length, the incision narrow, V-shaped. Lateral lobes created by incision of tergite nine acute. Cercus conical, elongate, broadest in basal one-quarter, gradually narrowed to apex, two and one-half times longer than basal width. Cercus sparsely clothed with delicate setae. Subgenital plate (fig.

96). Ovipositor slightly longer than hind femur, with low tuberculations, these concentrated on lateral face of dorsal valve; dorsal and ventral valves rather blunt, the tips of the dorsal and ventral valves meeting in the same plane. Coloration much as in male. Pile of cercus and femur white. Ovipositor dorsally black at base forming a single black spot on each face of dorsal valve. Black at base of ovipositor continuing dorsad along midline forming a medial stripe from base to apex, the basal one-quarter broad, extending on to dorsal face of dorsal valve; apical two-thirds of medial dorsal stripe brown; apical one-seventh of ovipositor brownish, the extreme apex black; latero-medial separation of dorsal and ventral ovipositor valves emphasized by a continuous longitudinal stripe from base to apex, the apical one-fifth broad, spanning entire ventral valve; color of median stripe light brown basad becoming darker brown apicad.

Variation. — The most obvious variation seen within the series collected by me is that of color. Among the rather large sample (103 specimens) not a single individual possesses the longitudinal stripes seen in *I. bechteli.* A single specimen has a greenish overcast, especially on the legs and on the distal portions of the abdominal terga. Two others show a reduced amount of green, this color being absent from the abdomen but more intensely indicated on the appendages than in other specimens more typical of the series.

Morphologically, the species shows considerable variation in the degree of inflation of the cercus of the male. The holotype (fig. 36) illustrates the extreme in the most bulbate condition of this structure. Specimens from Smoky Canyon, Nevada may have the condition as illustrated or have the cercus slightly more elongate, the inner angle more C-shaped. No specimen is like that of *I. elegans,* although some approach that species in the form of the main shaft. The position of the main tooth is the same in all examples and is different from that of *I. elegans.* Males with the condition approaching *I. elegans* were placed with females of that species and no copulations resulted.

Chromosome number. — 2N = 29. Three males collected at Smoky Canyon had the following chromosome complement: 2V + 26R + XR = 29.

EGGS. — Eggs of captive females collected at both Donnelly Creek and near Smoky Canyon, Nevada, agree with number 63 (light brown grey) on the ISCC Color Chart. Egg measurements in Table 9.

Seasonal occurrence. — Adults of *I. magnificus* are known from as early as 9 July (Nevada localities) to as late as 25 August (Cedar Peak, California).

Song. — The aggregative song of *I. magnificus* is illustrated in Plate 1. Males perform the calling song during the day and elicit short "zics" when disturbed. This latter call, or something very similar, is also heard at night.

Distribution. — *I. magnificus* is known from two localities in northwestern Nevada and Cedar Peak, Modoc County, California (fig. 18).

Records. — CALIFORNIA: MODOC COUNTY: Cedar Peak, 8,000-8,400 ft. elev., 25 August 1922 (J. Rehn, M. Hebard, 1 ♂, holotype, ANSP). NEVADA: HUMBOLDT COUNTY: Donnelly Creek, 2.4 mi. W. Parman Ranch, 4,500 ft. elev., 11 July 1969 (R. C. Bechtel, P. C. Martinelli, 27 ♂♂, 16 ♀♀, DCR, NSDA). HUMBOLDT-WASHOE COUNTY LINE: 4.5 mi. S. High Rock Lake, nr. Smoky Cyn., 4,900 ft. elev., 9 July 1969 (R. C. Bechtel, P. C. Martinelli, D. C. Rentz, 20 ♂♂, 28 ♀♀, DCR, NSDA). 5 mi. NE. Vya-Gerlach road on High Rock Lake road, 5,100 ft. elev., 9 July 1969 (R. C. Bechtel, P. C. Martinelli, D. C. Rentz, 6 ♂♂, 5 ♀♀, DCR, NSDA).

Specimens studied. — 103, including holotype.

Hosts. — I have found *I. magnificus* seemingly in the same ecological situation as *I. bechteli.* At the two County line localities in Nevada listed above, the species was abundant and found solely in hop sage, *Grayia spinosa,* inside of which a group of up to nine individuals could be found. Few, if any, greasewood plants were present at the High Rock Lake road, Nevada, locality although extensive flatlands were vegetated by this plant at the other locality. At Donnelly Creek, Bechtel (per. comm.) found the species mostly on *Atriplex torreyi* on the alluvial fan at the base of the hill. On the hillside itself, specimens were found on *Grayia spinosa* and to a lesser extent on *Tetradymia* (either *canescens* or *glabrata*).

Discussion. — *I. magnificus* poses one of the most peculiar problems of the genus. The holotype was collected from an area which is atypical for the *elegans* Group. The type locality, near Cedar Peak, California, has been visited by me on a number of occasions. In June 1960 I collected intensively in the Fandango Pass area of the northern Warner Mountains, but did not find a single representative of the genus *Idiostatus.* In 1969 the species was located in adjacent Nevada but still no specimens were found at the type locality. The field notebook of the original collectors was utilized to trace the exact collection of the holotype. The locality was discovered and no specimens found. Of interest is the fact that the type locality is quite atypical of the habitat usually occupied by species of the *elegans* Group.

It was not until 1969 that I became aware of the potential population numbers of species in the *elegans* Group. Heavy late spring rains in Nevada apparently triggered a population explosion among the insects of the Great Basin community. Certain weevils (e.g., *Rhynchytes velatus* LeC.), feeding on desert peach, which had not

been seen for years, were suddenly abundant. *Melanoplus rugglesi,* a migratory grasshopper with distinct solitary and migratory phases, was abundant in areas from which it had been absent for many years. Species of the *elegans* Group were also common enough to be of economic concern in the Rocky Canyon, Nevada, area. Field trips to the Saltbush-Greasewood and Juniper Steppe Woodland communities yielded four species of the *elegans* Group, two of which were new to me.

Upon discovering a member of the *elegans* Group in Greasewood ten miles east of Cedarville, California (fig. 18) in 1969 I assumed that I had finally located *I. magnificus.* This proved to be incorrect when it was found to be still another new species, *I. martinellii.* The disjunct nature of the pattern of distribution of this species is not unlike that of others of the species group, see *I. elegans* (fig. 18). This may be explained in part by the wandering or nomadic tendencies of populations of the *elegans* Group.

The type of *I. magnificus* has been examined by me on several occasions and I now conclude that it is atypical of the species and aberrant in many characteristics. Its small size has been matched only among a small number of atypical specimens of *I. bechteli* and *I. martinellii* which were collected during the "outbreak" year of 1969. The coloration of the pronotum and dorsum of the abdomen (Plate 8) is unlike any other individual of the species examined by me. Even among species possessing striped individuals, *I. bechteli,* the peculiar pattern seen in the holotype of *I. magnificus* is unique. The cerci and titillators are well within the range of variation seen among the series from Nevada, although they show no development of the basal callosities (compare figs. 35 and 36). This latter condition may be developed after the last molt and the type of *I. magnificus* may have been teneral when it was collected as indicated by the lightly sclerotized condition of the arm of the titillator.

I. magnificus is most closely related to *I. elegans* based on the structure of the cerci and the color pattern. When placed together in the laboratory, courtship occurred with repeated attempts at copulation. In each of the four observations, mating was not successful, the male's cerci failing to couple with the subgenital plate of the female. Both attempts with females of one species, males of the other, elicited the same response. The song is distinct from that of either

I. elegans or *I. martinellii* and the chromosome complement is also distinct.

An interesting instance of possible sympatry of two species in the *elegans* Group was recorded 4.1 miles south of High Rock Lake, Nevada, which is in sight of Smoky Canyon where *I. bechteli* was found. The terrain is continuously flat and while it is likely the two species occur together somewhere, I was unable to show it. There did seem to be a suggestion of host preference. At Smoky Canyon *I. magnificus* was found in saltbush, *Atriplex confertifolius* and hop sage, *Grayia spinosa*. These plants occurred at the former location but greasewood was more abundant and the small population of *I. bechteli* was confined to it, although at the type locality it was found on all three plants.

These katydids were always found in groups near the center of the bush whether saltbush or hop sage, and at the slightest disturbance moved even closer to the center of the plant. Trampling the green but brittle plant gave the best collecting results and the katydids were seen to dig into the litter at the base or hide among the dead portions of the accumulated branches and leaves. Upon capture males emitted a sharp "zic" sound quite unlike the low and somewhat prolonged "zic" heard during the day or early evening.

Idiostatus elegans Caudell (Figs. 1, 18, 37, 68, 97; Plates 1-4)

Idiostatus elegans Caudell, 1907, pp. 384-385, figs. 71, 72.
Idiostatus elegans, Caudell and Hebard, 1912, p. 167. Lectotype designation, "the figured male of Caudell, 1907." Data below.

Type data. — In Riker mount, three labels. 1. (printed) "F. H. Hillman, 6/15/90, Reno, Nev." 2. (red printed USNM label) "Type no. 10185, USNM." 3. (handwritten) "*Idiostatus elegans* type Caudell."

Type locality. — Reno, Nevada. No further information concerning the collection of the type series is available. The Hillman specimens were originally in the Bruner collection (Caudell, 1907:72).

Deposition of lectotype. — The lectotype is in the U.S. National Museum, No. 10,185.

Diagnosis. — Size large for genus (largest species), form extremely robust. Coloration grey in life, this becoming brownish in museum specimens; green or variegated forms unknown. Males distinctive in the following characters: mid-

dle tibia sulcate on anterior lateral margin; lobes of tergite ten broadly rounded; cercus elongate (fig. 37), swollen mesad, inner tooth short, stout, emanating dorsad from proximal one-third. Titillator with callosities (fig. 68), arm bowed outward, well serrated on outer margin. Females may be identified by the following: tergite ten with narrow V-shaped medial incision; tegmen with five major longitudinal veins, the outer pair bowed laterad; cercus conical, three to four times longer than basal width, apex acute, directed outward. Ovipositor almost as long as hind femur. *I. elegans* is an occupant of the Sagebrush-Steppe plant community.

Species description. — MALE. Size large for genus (largest species), form very robust. HEAD with fastigium of vertex very low, broad, in height barely attaining one-half length of first antennal segment. Eyes large, not greatly bulging, dorso-ventrally elongate. First antennal segment broad, three times broader than second: third segment subequal to second. Antenna slightly exceeding abdominal apex. PRONOTUM smooth dorsad, never polished. Anterior one-fifth of dorsum of pronotum with shallow, undulant, transverse sulcus, obsolete in median portion of disk. Surface of disk with shallow V-shaped sulcus, this deeply engraved basad, gradually decreasing in depth to apex; median carina, if present, weakly indicated, mostly by color, obsolete in central portion. Posterolateral angles of pronotum broadly bent, not at all suggestive of carinae. Anterior and posterior dorsal margins of pronotum truncate to slightly concave; anterior margin straight; posterior margin gently concave mesad; ventral margin broadly obtuse; surface with broad, smooth rugae. TEGMINA protruding beyond apex of pronotum for a distance of up to one-half the dorsal length of pronotum. APPENDAGES. Legs appearing somewhat shorter than normal for genus; posterior femur protruding beyond apex of abdomen for only one-quarter its length. Fore femur shorter than dorsal length of pronotum. Middle tibia broadly swollen dorsad in proximal region, a distinct longitudinal sulcus present on distal one-third of lateral surface of tibia. Outer surface of distal one-fifth of hind tibia with sulcus as described. Fore and middle femur armed on anterior ventral surface with three to five short, stout teeth. Plantula of hind tarsus short, stout, apex truncate, upturned; plantula one-third to one-half length of metatarsus. First tarsal segment short, only slightly longer than second, subequal to second and third combined. Hind femur armed on inner and outer ventral margins with four to nine stout teeth. ABDOMEN dorsally smooth, without median carina, microstructure (Plate 2); dorsal surface appearing smooth but with micropile. Median portion of abdominal tergites nine and ten specially modified. Tergite nine depressed mesad, broadly indented; surface of impression with widely scattered tuberculate sensory structures each with a seta emanating from its center. Tergite ten more modified mesad, soft, membranous, without widely scattered tuberculae but densely pilose; lobes broadly rounded. Cercus (fig. 37). Subgenital plate subcarinate in region of style; medial incision prominently V-shaped for a distance of one-quarter length of plate; style very elongate, as long as length of one side of medial incision. Surface of subgenital plate glabrous, not pilose. Titillator (fig. 68). COLORA-

TION. General overall coloration in life slate grey, this changing to dark brown in museum specimens. Abdomen unicolorous grey, without longitudinal stripe. Posterior margin of each abdominal segment whitish, this somewhat expanded anteriorad on some specimens. Head light brown, fronto-clypeal suture black laterad. Eye mottled grey brown, without ring. Dorsum of first antennal segment without or with one to four black markings, irregular in shape. Entire occipital region dark brown to polished black, this lighter in region of vertex where it may appear as a short longitudinal stripe. First and second antennal segments grey to light brown; flagellum dark brown, the distal one-third to one-half of each segment darker than base. Pronotum with anterior three-quarters of disk unicolorous with predominant abdominal color with following exceptions: lateral portions of pronotum with irregular black markings, V-shaped median sulcus dark black, this continuous along median region distad to apical one-quarter; humeral angles of pronotum black; distal one-quarter of pronotal disk contrasting pink in life changing to lighter brown, often reddish brown in dried specimens. Tegmen reddish brown, the veins lighter than the membranous cells. Prosternum with black horizontal stripe. Thorax marked laterad irregularly with black. Dorsal surface of all tibia black, at least in medial one-third; anterior lateral surface with irregular black area. Distal one-quarter of internal lateral portion of middle tibia and distal one-fifth of outer surface of hind tibia black in region of sulcus. Fore and middle femora marked dorsad with several round, black spots, the remainder uniform yellow brown or grey brown. Hind femur marked basally with black on dorsal surface; dorsal mediolongitudinal portion with black longitudinal stripe; distal portion with black subapical annulus; outer pagina without marking on ventral one-half to two-thirds, the above mentioned dorso-lateral stripe the sole marking. All spines with black basal portion adjacent to spine; dorso-lateral surface with narrow black stripe continuous from base to apex. All femoral teeth uniform, polished black. Tarsi light brown dorsally, darker ventrally. Plantula light brown or creamish in basal two-thirds, distal one-third dark brown to black. Abdomen unicolorous as described except for tergites eight, nine, ten which are polished jet black except for mesal area which is light grey in tergites eight and nine but straw brown in tergites nine and ten. Pile of segments eight and ten whitish, the sockets of the setae of tergite nine brown. Cercus in life pink, fading to light cream color, apex pinkish; inner tooth brownish basad, apex dark brown to black; setae dark brown. Subgenital plate uniformly cream colored. Abdominal tergites each with a black longitudinal stripe on each side, the stripe being one-half to two-thirds as long as segment.

Holotype measurements. — From Caudell (1907:385). Pronotum, 9.00 × 6.50; hind femur, 22.00; tegmen, 4.50.

FEMALE. Similar to male but with following exceptions: size larger, abdomen more robust; tegmen protruding for a distance of one-fifth to one-third dorsal length of pronotum; female tegmen with five major longitudinal veins, the outermost two heavier, better defined and distinctly bowed laterad; innermost veins straight, thinner; tergite nine without medial modification; tergite ten

with narrow, V-shaped medial incision well indicated. Cercus conical, elongate, three and one-half times longer than basal width; apical one-quarter acute, distinctly directed outward. Cercus sparsely clothed with long pile, some of the individual hairs up to one-quarter the length of cercus itself. Subgenital plate (fig. 97) modified basad. Ovipositor almost equal in length to hind femur; lateral surface without tuberculation, this feature indicated solely by color, ventral valve with broad dorsal subapical carina on lateral surface; apex blunt, without narrowed sharp point. Coloration much as in male. Ovipositor dorsally black at base; dorsal surface with narrow, black medial stripe along midline from base to apex; lateral surface with similar, though broader midline stripe on lower valve attingent to dorsal valve from base to apex; apex dark brown to black, subapical region infuscate; apical one-quarter to one-fifth of lateral surface of valves with brown speckles, these in place of tubercles.

Allotype measurements. — From Caudell (1907:385). Pronotum, 9.50 × 7.00; hind femur, 24.00; tegmen, 3.00; ovipositor, 26.00.

Variation. — Individuals of *I. elegans* exhibit little variation in size or color pattern, in contrast to other members of the genus or even other members of the *elegans* Group.

The titillators of the male show a degree of variation in the number and sclerotization of the callosities (fig. 68). These invaginations of the phallic membrane may be either well sclerotized or but little sclerotized and weakly defined. The greatest number of such callosities observed was five on each side of the titillator (Cow Creek, Nevada), the least was three (Rocky Canyon, Nevada, fig. 18). The length of the arm may also be slightly longer than illustrated. Most species have the titillator teeth directed dorsad rather than laterad but such an extreme in variation may be found on a single specimen from one side to the other.

The shape of the cercus of both sexes is surprisingly monomorphic in *I. elegans*. This uniformity is not found in other members of the species group, especially in the related *I. magnificus* which shows considerable variation in the degree of inflation of the bulbous portion of the cercus.

Chromosome number. — 2N = 29. Three males collected at Rocky Canyon had the following chromosome complement: 2V + 26R + XR = 29.

EGGS. — Eggs of *I. elegans* obtained from females collected near Rocky Canyon, Nevada, matched well with number 60 (light grey brown) on the ISCC-NBS color chart. Egg measurements are given in Table 9.

Seasonal occurrence. — *I. elegans* like other species of the *elegans* Group matures early in the summer. Adults are known from 30 May (Reno, Nevada) to 24 July (Reno, Sun Valley, Nevada). A single record is labelled August (Reno, Nevada).

Distribution. — *I. elegans* is known (fig. 18) only from rather widely disjunct locations in Nevada. The species had been infrequently collected in the vicinity of the type since 1900 but recently

was discovered in the 7-Troughs Mountains north of Lovelock, Nevada.

Records. — NEVADA: PERSHING COUNTY: Cow Creek, 7-Troughs Mts., 37 mi. NW. Lovelock, 25 June 1969 (C. A. Heringer, P. C. Martinelli, 3 ♂♂, 6 ♀♀, NSDA). Rocky Cyn., 7-Troughs Mts., 5,000 ft. elev., 35 mi. NW., Lovelock, 27 June 1969 (J. R. Adams, F. Hilbig, 1 ♀, NSDA); 1 July 1969 (R. C. Bechtel, D. C. Rentz, 81 ♂♂, 23 ♀♀, DCR, NSDA). WASHOE COUNTY: Reno, August 1949 (G. S. Schweis, 2 ♂♂, 3 ♀♀, USNM); 30 May 1951 (F. T. Cowan, 2 ♂♂, USNM); Peavine Mt., 9 June 1940 (I. La Rivers, 1 ♂, 1 ♀, UN); Sun Valley dist., 3 July 1969 (Hamilton, 1 ♂, NSDA); 24 July 1969 (R. C. Bechtel, P. C. Martinelli, 2 ♂♂, on *Grayia spinosa,* NSDA).

Specimens studied. — 126, including lectotype.

Hosts. — *I. elegans* is omnivorous, but because of its large size, the species may be an effective predator. At Rocky Canyon, Nevada, this species was found together with *I. hermannii* and *Anabrus simplex,* the latter in considerably smaller numbers than either of the *Idiostatus.* At that time all of the decticines were concentrated in and around the dense, green foliage of tansy-mustard, *Descurania sophia* (L.). Many individuals of all three species could be seen feeding on the plants but four observations of *I. elegans* feeding on other insects were also recorded. *I. elegans* was seen feeding on struggling individuals of the following species: *I. hermannii, Aulocara elliotti, Oedaleonotus enigma* (two observations). If carelessly handled, *I. elegans* readily bites even more so than the larger and less aggressive Mormon cricket. These observations indicate that *I. elegans* is more predaceous than has been noted for other species in the genus. Even though *I. hermannii* was present in larger numbers at Rocky Canyon, Nevada, not a single individual of that species was discovered feeding upon anything but plant material. The mandible of *I. elegans* (fig. 1) is very similar to that class of katydids termed Carnivorous-forbivorous or flesh-forb feeding subtype as defined by Gangwere (1965) which are characterized by possessing a long hook-like mandible, incisor and molar dentes sharp and well defined, surrounding a distinct molar concavity.

Perhaps under more normal conditions where species are present in smaller numbers, *I. elegans* is likely to be more forbivorous. With the grasshopper and katydid numbers in the quantities observed in 1969, the opportunity for the role of a carnivore was appropriate and *I. elegans* seemed to fill it.

La Rivers (1948) recorded *I. elegans* as feeding upon wild sunflower, *Helianthus* sp., in a sagebrush flat near Reno, Nevada. None of this plant was present in the Rocky Canyon, Nevada, locality.

Discussion. — *I. elegans* was little known in collections until 1969. Indeed, it was the solely described member of its species group until that year, since the status of *I. magnificus* was in doubt. Seemingly the heavy, extensive rains of the winter and late spring of 1968-69 triggered the emergence of large numbers of individuals of this and other species in the *elegans* Group with a high success ratio of nymphs attaining adulthood. When we were at Rocky Canyon, Nevada, at the beginning of July, hundreds of specimens of both *I. elegans* and *I. hermannii* could have been collected. Representatives of the Nevada State Department of Agriculture are continually in the field during the summer months and would have reported any such population explosion as described above in previous years or in other areas during 1969. Their records indicate that these occurrences are sporadic and correlated with climatic phenomena, usually wet weather. Eggs may remain in a diapausing or quiescent condition until certain requirements are met. Another possibility was suggested by Mr. Norman Anderson (personal communication). He stated that his work on rangeland grasshoppers in Montana is revealing a cyclic phenomenon among a number of mid-western grasshopper species not unlike that which has been demonstrated in many northern birds and mammals. Perhaps some such cycle is acting with *I. elegans.*

Members of the *elegans* Group, and to some extent species in the *hermannii* and *inermis* Groups, show aggregative and mass movement tendencies. The large *I. elegans* is a ground-dwelling insect which I always found concentrated in dense populations such as at Rocky Canyon, Nevada, but completely absent just a quarter of a mile or less away. The population may move either during the day or at night, the latter being the more frequently observed situation. R. C. Bechtel and P. C. Martinelli returned to Rocky Canyon on 29 July 1969 and (as discussed in *I. hermannii*) found not a single katydid in the area of original collection. Both species had moved to a lower elevation in an area where we had found no decticines during our first visit. Where the females lay eggs is of critical importance. Since the species moves around to a considerable degree, one would expect either the females to lay eggs randomly, and then the species would

be more widely distributed, or lay eggs only at certain specialized places. In the laboratory females oviposited almost immediately when sand or soil was offered. Perhaps in the field, eggs are continually laid as the population moves and only those deposited under proper ecological conditions hatch while others either die or diapause until conditions become favorable.

I. elegans is most closely related to *I. magnificus,* a species with rather similar habits. Crossing experiments were attempted in the laboratory to discover whether copulation and spermatophore transmission would occur between individuals of both species. Individuals of the former species from Rocky Canyon, Nevada, were placed with katydids of *I. magnificus* from Smoky Canyon and Donnelly Creek, Nevada. Courtship, palpation and copulation were attempted but achievement of spermatophore transmission was not observed in 11 such experiments. As with other attempts at inter specific matings in this study, the shape of the cercus and the corresponding subgenital plate are effective isolating mechanisms. Even more dramatic was the condition when the more distantly related *I. bechteli* was placed with *I. elegans* (compare figs. 37 and 38). Courtship proceeded as normal for species in this group but the males' very different cerci failed to properly grasp the subgenital plate of the female and copulation was not accomplished.

Idiostatus bechteli new species (Figs. 14, 18, 38, 69, 98, Plates 1-8)

Type data. — Three labels, all printed. 1. "Nevada, Humboldt Co., Soldier Meadows, 15 mi. W. Pahute Peak, 4400, 8 July 1969, David C. Rentz." 2. "R. C. Bechtel, P. C. Martinelli collectors." 3. "W. W. Middlekauff collector."

Type locality. — Soldier Meadows is located on the northeast base of the Calico Mountains on Fly Creek in section R24E, T40N. The holotype, and most of the type series, was collected near the hot springs.

Deposition of primary type. — The holotype and allotype are deposited in the California Academy of Sciences, No. 10,488.

Diagnosis. — Size large for genus, medium to small for *elegans* Group, form robust. General coloration greyish often striped longitudinally; green forms in up to 20% of population. Males distinctive in following characters: cercus bifurcate (fig. 38) ventral tooth nearly same or slightly longer than dorsal tooth,

never as in *I. martinellii.* Titillator (fig. 69) much as in *I. martinellii.* Females may be identified by the following combination of characters: cercus very stout, straight in basal two-thirds, thence narrowed, directed mesad and ventrad. Subgenital plate (fig. 98). *I. bechteli* is an occupant of the Greasewood-Saltbush plant community (Küchler, 1964) of the north western portion of Nevada (fig. 18).

Description. — HOLOTYPE MALE. Size large for genus, form robust. Head with fastigium of vertex very low, broad, only slightly surpassing length of first antennal segment. Eyes large, nearly cordate in outline, hardly protruding, almost flat with gena. First antennal segment broad, as broad as long, three to four times broader than second segment. Third antennal segment slightly longer than second, half as long as first. Antenna very thin, thread-like, slightly exceeding apex of hind femur. PRONOTUM smooth dorsally, not polished, but with micro granulations, detectable only under high magnification. Dorsum of pronotum very shallow, undulant transverse sulcus on anterior one-fifth, this sulcus obsolete in median portion; median portion of disk with short, stout, V-shaped sulci more deeply engraved apicad than basad; median carina not indicated on type, scarcely indicated on small percentage of type series; posterior one-third of disk with broad, shallow sinus on each side; posterolateral angles of disk broadly rounded, not at all suggestive of lateral carinae; anterior and posterior margins of disk distinctly concave mesad; anterior margin of lateral lobe broadly convex; posterior margin of lateral lobe concave mesad, not produced caudad; surface of lateral lobe mostly smooth but with broad rugae mesad and anteriorad. TEGMINA (fig. 14) protruding beyond apex of pronotum for a distance of one-third (type) the dorsal length of pronotum. APPENDAGES. Legs appearing shorter than normal for genus; hind femur protruding beyond apex of abdomen for a distance of only one-fourth its length. Fore femur shorter than pronotum. Middle tibia only slightly swollen proximad, sulcus on outer surface only barely indicated in distal one-quarter. Outer surface of distal one-fifth of hind tibia with sulcus indicated only by color. Hind femur armed on inner and outer ventral margins with six to twelve short, stout, uncinate teeth. Plantula of hind tarsus short, stout, less than one-quarter as long as metatarsus, apex obtuse. Metatarsus elongate, as long as next two segments combined. ABDOMEN dorsally smooth, without median carina; surface sparsely pilose. Median portion of abdominal tergites nine and ten soft, membranous, with rather dense, long pile. Tergite nine less modified than tergite ten which is very soft; surface of tergite ten with low rugae at base of each seta, this detectable only under magnification. Posterior portion of tergite ten broadly truncate laterad, weakly produced. Cercus (fig. 38). Subgenital plate longer than broad, weakly subcarinate ventrad; median excavation well indicated, V-shaped to a depth of one-quarter the length of plate itself; style very elongate, as long as length of one side of median incision. Surface of subgenital plate sparsely pilose. Titillator (fig. 69) with three or more sclerotized basal callosities. COLORATION. General coloration in life slate grey, with a considerable amount of individual variation in this species. Holotype with abdo-

men and pronotum slate grey in life becoming grey brown in dry specimen; posterior margins of abdominal terga white forming a narrow lateral band. Head darker brown, almost black dorsad of eyes, lighter below, mottled. Eye grey in anterior and dorsal one-half, black or darker grey laterad, lighter mesad. Second and third antennal tergites brownish, the second segment with a trace of grey dorsad. Flagellum of antenna uniform dark brown. Pronotum with anterior three-quarters of disk darker brown contrasting with distal one-quarter which is pinkish grey; median portion of disk in area of V-shaped sulci black, the black extending beyond the sulci; lateral lobes darker brown, not black; posterior portion of lateral lobe with broadly bowed whitish area extending from humeral angle to apical region of ventral margin. Tegmina uniformly reddish brown, the veins contrastingly lighter in color. Prosternum without black lateral stripe but with two indistinct brown lateral spots, these merely sclerotization of base of apophysis. Thorax otherwise unmarked except for inverted V-shaped small black mark mesad on mesothorax. Anterior surface of fore tibia with black stripe in distal one-half, the stripe broadest distad, tapering to apex. Auditory foramen rimmed with black. Middle tibia similarly marked but stripe somewhat reduced in length and brownish in color. Fore and middle femora uniform grey or greyish brown, on anterior surface greenish blue on posterior surface near base, without black stripe. Anterior surface of middle tibia greyish in dorsal one-half, greenish in ventral one-half, this area separated by the brownish stripe. Hind femur mottled greyish with small number of black markings. Base of hind femur marked dorsally with two rows of nine black spots, the basal spots more elongate, coalesced. Dorsal median portion of hind femur marked with short rectangular black stripe, truncate at both ends, of uniform width. This stripe matched by similar stripe on inner face of hind femur. Hind tibia pale blue green except for light brown oblique stripe on outer surface in distal one-sixth, this stripe broadly rounded distad, tapering to apex; inner surface as described except oblique stripe lacking and basal one-third with brown speckling on ventral border. All spines whitish or light cream in basal one-half, distal one-half black. Dorsal surface of each spine with narrow black stripe running from base to apex. All femoral teeth black throughout, the black extending for a considerable distance on ventral anterior border. Tarsi lighter brown dorsad than ventrad. Plantula light straw brown on outer surface, apex, perimeter and internal surface darker brown. Abdomen as described except dorsal surface of abdominal tergites eight, nine, ten specially modified. Median portion of tergite eight with small inverted crescent of brown, lateral portions unmarked. Tergite nine marked heavily with black laterad, with irregular indistinct dark brown to black margins dorsad; mesad lighter, this portion distinctly softer, membranous. Tergite ten uniformly black except for light straw brown median membranous region and latero-distal portions of tergum. Ventral surface of abdomen light straw brown; each side of each segment with oblique black stripe. Cercus uniform light straw brown except for teeth which are brownish basad, black at apex. Pile of body white, of cercus brown.

Holotype measurements. — Length, 29.00; pronotum, 8.80 × 6.30; fore

femur, 6.80; tibia, 8.80; middle femur, 8.10; tibia 9.80; hind femur, 23.20; tibia, 22.30.

ALLOTYPE FEMALE. Similar to male but with following exceptions: size slightly larger; tegmen protruding beyond apex of abdomen for a distance of approximately one-sixth the dorsal length of pronotum. Tergites eight and nine without median modification. Tergite ten with rather broad V-shaped medial excavation. Cercus conical, broadest basad, little more than twice as long as basal width, rather stout in basal two-thirds, abruptly narrowed to acute apex in distal one-third; apex very sharply pointed, highly sclerotized, distinctly directed inward and ventrad. Cercus clothed with both long white pile and short, stout brown setae. Subgenital plate (fig. 98) broad basad. Ovipositor almost equal in length to hind femur; lateral surface of apical one-sixth with low granulations, these indicated mostly by color; dorsal and ventral valves without serration; ventral valve carinate, dorsolateral apex blunt, dorsal valve weakly directed ventrad. Coloration much as in male; cercus much as in male, apex black. Ovipositor dorsally black at base, this indicated as two black spots; dorsal surface with narrow, black medial stripe along midline only in apical one-third, black confined to lateral dorsal lobes of valves in basal portion; lateral surface unicolorous grey except at apex where it is black on margins and along border of ventral and dorsal valves; apical one-fifth of lateral surface with small, irregular dark brown speckles, these either indicative of or not indicative of tuberculations.

Allotype measurements. — Body, 30.20; pronotum, 9.10 × 6.00; fore femur, 7.60; tibia, 9.20; middle femur, 8.80; tibia, 10.80; hind femur, 24.00; tibia, 23.10; ovipositor, 24.10.

Variation. — Variation in color and structure are both evident in *I. bechteli.* A series of specimens from the type locality shows surprisingly little size variation except for three atypically small individuals. The shape of the cercus is as described for the holotype in males with the exception that three specimens show a wider angle of separation of the two teeth. The most individually variable characteristic is that of the number of femoral teeth. A single individual may possess three teeth on one side, seven on the corresponding opposite appendage.

I. bechteli shows more variation in color than any other species of the *elegans* Group. The most commonly encountered phase is that illustrated by the primary types (uniform grey). The next most common is a green phase, the intensity of which seems individually variable. At least one green male shows a reduction in the banding of the abdomen of tergites eight to ten to having black only on tergite ten. Another green male shows black on all three segments. Approximately 15-20% of the specimens in my sample are of the grey phase but possess a lighter brown dorsal longitudinal stripe as wide as the dorsum of the pronotum and extending from vertex of head to abdominal apex. This condition is very similar to that described for *I. inermis* and *I. hermannii* but percentage wise is different.

The cerci of *I. bechteli* males show considerable constancy in the length of the two apical teeth. Although similar in overall morphology to the cerci of *I. martinellii*, detailed examination shows the basic difference in the two morphotypes (compare figs. 38, 39). In the series of specimens before me only two topotypic representatives approach the latter species in this character. The apical tooth in each example is longer than expected, however, the angle between the teeth is typical of *I. bechteli*.

Chromosome number. — 2N = 29. Four males from the type locality had the following chromosome complement: 2V + 26R + XR = 29.

EGGS. — Eggs from topotypes were collected in the laboratory and agreed with number 63 (light brown grey) on the ISCC-NBS color chart. A single captive female collected at the type locality on 8 July 1969 as an adult laid 292 eggs between that date and her death on 22 September 1969. This is the largest number of eggs recorded from a single individual. Egg measurements, Table 9.

Derivation of name. — I take pleasure in naming this species in honor of Robert C. Bechtel of the Nevada State Department of Agriculture. The interest he has shown in this study is sincerely appreciated.

Seasonal occurrence. — *I. bechteli* has been collected only at the beginning and middle of the month of July.

Song. — The song of *I. bechteli* is diagrammed in Plate 1. The typical calling song is heard during the day and the short "zic" call is often heard at night.

Distribution. — *I. bechteli* is known from a small number of locations in the Calico Mountains of Nevada and the adjacent northern flanks of that range (fig. 18).

Records. — NEVADA: HUMBOLDT COUNTY: High Rock Lk., 5,000 ft. elev., 9 July 1969 (D. C. Rentz, 1 ♂, DCR). Soldier Mdw., 6 July 1961 (F. D. Parker, 9 ♂♂, 3 ♀♀, NSDA); 5,000 ft. elev., 16 July 1964 (R. C. Bechtel, P. C. Martinelli, 3 ♂♂, 2 ♀♀, 3 last instar ♂♂, 3 last instar ♀♀, NSDA); 15 mi. W. Pahute Peak, 4,400 ft. elev., 8 July 1969 (R. C. Bechtel, P. C. Martinelli, W. W. Middlekauff, D. C. Rentz, 56 ♂♂, 13 ♀♀, DCR, NSDA); 5 mi. S., 3 July 1956 (H. E. Gallaway, 4 ♂♂, 4 ♀♀, NSDA); 6 July 1960 (F. D. Parker, 5 ♂♂, 5 ♀♀, NSDA).

Specimens studied. — 111; holotype, allotype, paratypes.

Hosts. — *I. bechteli* has been found on a variety of plants all of which are members of the Greasewood-Saltbush community. At the type locality, most individuals were found in greasewood bushes, the predominant plant at the lower elevations. On the slopes above, where the terrain is more rocky and the habitat considerably drier,

fewer greasewood bushes are present but hop sage is more abundant. The katydids were almost totally confined to the latter which were more herbaceous and apparently afforded more protection. At High Rock Lake, Nevada, *I. bechteli* was found in greasewood.

Discussion. — At the time of its earliest collection (1956), this species was present in numbers of two to three per square yard (NSDA records) in an area of 300 acres at Soldier Meadows, Nevada. The katydids were adjacent to pasture land and the large numbers prompted the Nevada State Department of Agriculture to spread poison bran over the area of infestation by truck. The decreased numbers of specimens during successive years (the area is visited by NSDA representatives several times each summer) led H. E. Gallaway of that department to believe that the species had been exterminated. However, collecting in subsequent years has established its continued presence in the area. Females likely laid eggs prior to the application of the poison and these eggs presumably led to the repopulation of the area. Since no further poison has been applied and since the original poison was said to be non-residual, the effect was likely limited to the adult katydids present at the time of first application.

I. bechteli shows about the same pattern of distribution and bionomics as do the other members of the *elegans* Group. It is present only during certain years, and at such times the species is locally abundant. In 1968, on 13 July I journeyed to the type locality with R. C. Bechtel to obtain specimens for this study. Two days and one night of intensive, wide-ranging collecting failed to yield a single individual. I was told of the previous collections made in 1960 and 1964 and how the bushes were "alive" with katydids and one could collect almost any number desired. In 1969 on 8 July we again went to the type locality after a period of unusually heavy spring rains. The area was greener, the plants more lush and the streams fuller. The same individual plants were checked and were occupied by the katydids. Where no singing was to be heard in the previous year, the air was alive with the calls of the insects. As we proceeded on our collecting expedition we found *I. magnificus* and *I. martinellii* similarly abundant. This cyclic phenomenon is especially pronounced among species of the *elegans* Group.

I. bechteli is closely related to *I. martinellii* but specifically different as indicated by laboratory crossing experiments, song pattern, and

morphology of the terminalia. The two species seem to occupy the same ecological situation.

When males of *I. bechteli* were placed with females of *I. martinellii* courtship behavior resulted but no spermatophore was transferred, presumably because of the difference in genitalic structure. The reciprocal attempts did result in the transmission of a spermatophore in one of three trials, but this was probably an unsuccessful mating since the spermatophore fell from the female eight minutes after transmission.

Idiostatus martinellii new species (Figs. 18, 39, 99; Plates 1, 8, 16-18)

Type data. — One label, printed. 1. "Calif., Modoc Co., 7-9 mi. E. Cedarville on Hwy. 299, 4,700 ft., 10 July 1969. David C. Rentz."

Type locality. — The precise type locality is the same as that given for *I. apollo*. *I. martinellii* was found on the asphalt surface of California State Highway 299 at night, a quarter of a mile east of Middle Alkali Lake.

Deposition of primary types. — The holotype and allotype are deposited in the California Academy of Sciences, No. 10,489.

Diagnosis. — Size large, form robust for genus. Coloration in life grey, becoming reddish brown in dried specimens; striped forms unknown. Tegmen tan, the veins contrastingly lighter. Males distinctive in following characters: cercus with teeth bifurcate (fig. 39), the apical tooth usually twice as long as inner tooth; internal tooth short, stout, directed ventrad. Females are distinctive in possessing four longitudinal veins running the full length of the tegmen; tergite ten with broad V-shaped medial incision for three-fourths its length; lateral lobes of tergite ten broadly rounded; subgenital plate (fig. 99). Cercus directed mesad throughout its entire length, apex spine-like, directed ventrad. Ovipositor almost equal to length of hind femur. *I. martinellii* is an occupant of the Greasewood-Saltbush plant community (fig. 18).

Description. — HOLOTYPE MALE. Size large for genus, form robust. HEAD with fastigium of vertex low, broad, hardly produced beyond first antennal segment. Eyes large, ovoid, not bulging, only very slightly dorso-ventrally elongate. First antennal segment as long as broad, one-third as wide as greatest width of eye. First antennal segment twice as long as second, three times broader. Third antennal segment equal in length to second. Antennae nearly attaining apex of hind femur. PRONOTUM smooth dorsad, never polished. Anterior one-fifth of disk of pronotum with shallow, undulant, poorly defined transverse sulcus, obsolete in median of disk, continuing on to dorsal anterior portion of lateral pronotal lobe. Mesal portion of pronotal disk with V-shaped sulcus, this more deeply engraved near midline, decreasing to shallow

sulcus laterad. Pronotum with faint indication of median carina, this indicated almost solely by color; anterior margin slightly concave, posterior margin slightly concave, distinctly upturned. Anterior margin of lateral lobe of pronotum straight; ventral border truncate to broadly obtuse; posterior portion weakly sinuate, the median portion distinctly but not greatly concave. TEGMINA. Tegmen (Plate 8) protruding beyond apex of pronotum for a distance of two and one-quarter times its dorsal length. APPENDAGES. Legs appearing somewhat shorter than normal for genus, apex of abdomen barely attaining apex of hind femur. Fore femur shorter than pronotum. Middle tibia swollen throughout distal five-sixths, quadrate in outline, the proximal one-sixth appreciably narrowed, cylindrical in outline. Fore, middle and hind tibiae with lateral external sulci indicated only by color. All tibiae sparsely pilose, the femora clothed dorsad with short, dense setae. Plantula of hind tarsus elongate, almost one-third as long as metatarsus, two and one-quarter times as long as basal width, apex truncate to obtuse. Proximal tarsal segment only slightly longer than second segment. Hind femur armed on outer margins of ventral surface with seven to eight short, triangular teeth; inner margin armed with eight to nine such teeth. ABDOMEN dorsally smooth, without any indication of median carina; dorsal surface appearing smooth, not polished, with dense micropile. Tergite nine modified mesad, soft, depressed, this area clothed with sparse, fine pile. Tergite ten extensively modified mesad, the modification occupying fully one-third of segment; surface mesal area with widely scattered tuberculate sensory structures; lateral lobes broadly truncate, not produced. Cercus (fig. 39). Surface of cercus densely clothed with short, bristly setae. Subgenital plate subcarinate in region of styles; incision well indicated, V-shaped for a depth of one-quarter the length of plate; style elongate, as long as one side of medial incision. Surface of subgenital plate and style sparsely pilose. Titillator apparently identical with that of *I. bechteli*. COLORATION. Overall coloration in life greyish brown, this becoming darker brown in death. Holotype with pronotum light mottled grey, darker on lateral lobes and in region of median V-shaped sulcus. Posterior margin of lateral lobe of pronotum with broad indistinct white arch, this bowed cephalad. Head greyish white ventrad, vertex and lateral portions black, this continuing on to ventral margin of eye. Fastigium of vertex mottled grey brown. First and second antennal segments greyish, third segment and flagellum dark brown, veins lighter. Thorax with transverse black prosternal stripe. Meso- and metathorax with black spots at base of each apophysis. Thorax laterally brownish with irregular black marking, especially along sutures or bases of coxae and trochanters. Fore tibia greyish on anterior surface, aquamarine green on posterior surface; anterior surface with black stripe occupying distal two-thirds of appendage; region of auditory foramen brownish. Fore femur grey with aquamarine overcast, a few brown speckles on dorsum at base. Median and hind legs similar in overall coloration as described for fore legs with following exceptions: black stripe on outer surface of tibia not as extensively developed, speckling of dorsum of femur more extensive in median femur. Hind femur marked dorsally at base

with two rows of broad spots, these more or less coalesced basad. Median portion of inner and outer surfaces of hind femur with small, quadrate spot; dorsal surface of apical one-quarter with black longitudinal stripe. All spines creamish in basal one-half to two-thirds, apex dark brown or black; dorsal surface with elongate narrow stripe continuous from base to apex. Socket encompassing spines of legs dark brown. All femoral teeth entirely jet black, this extending on femur at base for considerable area. Pile of tibiae whitish, of femora and cercus reddish brown. Abdomen greyish brown, anterior border of each segment ringed with black. Apex of each abdominal segment with narrow white annulus. Tergite nine entirely black except membranous area which is pinkish. Tergite ten black except for medial soft portion which is brown and the lateral distal portion of the tergum light brown. Cercus uniform medium light brown, internal and apical tooth darker brown, the extreme apex black. Abdominal sternites and subgenital plate creamish white. Each sternite with two elongate black marks, one on each side of anterior portion. All abdominal pile, including that of tergite ten whitish.

Holotype measurements. — Length: body (somewhat distended due to preservation), 38.00; pronotum, 8.40 × 5.60; fore femur, 6.10; tibia, 7.10; middle femur, 7.20; tibia, 9.10; hind femur, 19.30; tibia, 18.80.

ALLOTYPE FEMALE. Similar to male but with following exceptions: size larger, abdomen much more robust. Tegmen of allotype protruding only slightly beyond apex. Median longitudinal veins of tegmen not noticeably heavier than lateral net-like vein. Tegmen with four complete longitudinal veins, these in outer one-third; other longitudinal veins incomplete, bowed; medio-lateral one-third of veins net-like, quadrate or round cells. Abdominal tergite nine with only slight, broad medial excavation. Tergite ten with deep, broad, V-shaped incision for nearly three-quarters its length. Lateral lobes created by medial incision of tergite ten broadly rounded. Cercus conical, three times longer than basal width, distinctly directed mesad throughout its entire length; apical one-fifth spine-like, sclerotized, directed ventrad; entire surface sparsely pilose, the pile of two distinct lengths. Subgenital plate (fig. 99) broad basad. Ovipositor almost equal in length to hind femur; lateral surface of apical one-fifth with very feeble tubercles; dorsal and ventral valves without serration; lateral surface of ventral valve weakly carinate; apex relatively blunt. Coloration much as described for male with following exceptions: spine-like portion of cercus dark brown to black. Ovipositor dorsally black at base, this region of color continuous from base along midline to apex, the basal one-fifth broadly colored dark brown to black; lateral surface light wood brown, apex darker, the tuberculations and apex dark brown to black; lateral surface with narrow brown stripe along separation of dorsal and ventral valves.

Allotype measurements. — Length: body, 31.00; pronotum, 8.50 × 5.30; fore femur, 6.80; tibia, 8.20; middle femur, 8.20; tibia, 9.60; hind femur, 21.20; tibia, 19.60; ovipositor, 23.60.

Variation. — The series of this species shows little variation in color. No striped or green individuals have been found as are present in the related

I. bechteli. A surprising degree of variation occurs in the length and direction of the apical tooth of the cercus of the male of *I. martinellii.* Most specimens have the condition as described for the holotype but 10-12% of the males have the apical tooth somewhat shorter and more definitely directed anteriorad. In other respects, including size, the paratopotypic series is remarkably uniform.

EGGS. — A single topotypic female captured as an adult in the field on 10 July 1969 laid 59 eggs until her death on 19 August 1969. This is a considerably smaller number than seen in other species of this group which were kept similarly isolated (*I. elegans, I. magnificus*). The female may have laid some eggs at the time of capture or was otherwise inhibited in egg laying in captivity. Eggs from topotypic females agreed with number 60 (light grey brown) on the ISCC-NBS color chart. Egg measurements, Table 9.

Derivation of name. — I name this species in honor of Mr. Philip C. Martinelli of the Nevada State Department of Agriculture who has aided in obtaining much of the material from Nevada.

Seasonal occurrence. — *I. martinellii* is known only from its original collection. The type locality had been revisited both day and night on many occasions from 1960 to present, but the species was not seen. In early September 1969, I returned to the type locality and with the most intensive search, could locate no further specimens. Two possibilities explaining this situation come to mind. Perhaps the species is seasonally early and cannot tolerate the dry summer conditions which prevail from late July until early fall. Evidence for this is suggested by the observations that the katydids remain in the greasewood bushes during the day, venturing forth only at night. Another reason may involve the wandering or banding tendencies of the species. As discussed elsewhere, it seems that species of the *elegans* Group move in large groups within the range of the species, the insects being completely absent from an area where they were excessively abundant in previous weeks. See discussion of *I. elegans* for observations on this phenomena.

Song. — The "zic" song of *I. martinellii* is illustrated in Plate 1.

Distribution. — *I. martinellii* is known only from northeastern California and adjacent Nevada (fig. 18).

Records. — CALIFORNIA: MODOC COUNTY: Cedarville, 7-9 mi. E. on Hwy. 299, 4,700 ft. elev., 10 July 1969 (D. C. Rentz, 15 ♂♂, 38 ♀♀, CAS, DCR, holotype, allotype). NEVADA: WASHOE COUNTY: Cedarville, 10 mi. E., 1.8 mi. E. state line, 5,000 ft. elev., 10 July 1969 (D. C. Rentz, 8 ♂♂, 3 ♀♀, DCR).

Specimens studied. — 55, including holotype.

Hosts. — As with other members of the *elegans* Group, *I. martinellii* is associated with the greasewood-saltbush plant community. They seemed to occupy either greasewood or hop sage without preference. Adjacent to the area of the Nevada collection were broad expanses of big sagebrush and juniper. None of the katydids could be found in this contiguous but ecologically different plant community. Individuals collected at night were commonly seen feeding on road killed katydids or other insects. During the day, I saw two instances of adults feeding on greasewood.

Discussion. — The collection of a member of the *elegans* Group near Cedarville, California, was anticipated since the plant communities in the eastern portion of the state and adjacent Nevada are typical of those inhabited by this group.

I. martinellii was found with *I. apollo, Steiroxys* sp., and *Capnobotes occidentalis* in great numbers on the pavement at night. Several people working together could have collected hundreds of the former in a single night's collecting. The specimens from a short distance away (California-Nevada border) were found during the day, the gravel road surface being unsuitable for nocturnal collecting.

Descriptive notes for the type locality are the same as those given for *I. apollo*. Reason for the "sudden" outbreak of this species is pure conjecture. My colleague, Dr. Rudiger Hartmann, has subjected the eggs of topotypic females to a variety of temperature, humidity and light regimes since late fall 1969 and has succeeded in initiating eclosion after using several techniques to break diapause. As noted in the introduction, accumulating evidence suggests a form of obligate diapause in this stage. Further experiments will be performed to test this hypothesis.

The similarity of the terminalia of *I. martinellii* and *I. bechteli* prompted mating experiments which are discussed in detail in the account of the latter species. Comparison of the terminalia and songs of the two species in addition to the courtship data reveal the specific distinctness of the two forms.

The *aberrans* Group

This group (*I. aberrans, I. viridis*) possesses a peculiar combination of ecological and morphological characteristics. Only two species are known, both new and poorly represented in collections.

I. aberrans is presently known only from two rather widely separated localities, the male (holotype) from one, and the two female paratypes from two localities in relatively close proximity to each other. There exists the possibility that more than one species is represented but when morphological and ecological comparisons are made, there is good reason to conclude that only a single species is represented. The second species, *I. viridis,* is known from only two females, both from different localities. Differences in the structure of the female genitalia led me to believe that the southern *I. viridis* (Plate 9) is likely specifically different from the northernly *I. aberrans.*

From the above statement one could conclude that either a single species is represented in the five specimens I possess or that up to four species are present. Only additional collection of both sexes will help solve this problem. In any event, as indicated by the paucity of specimens from relatively well known collecting areas, species of the *aberrans* Group are rare.

Idiostatus aberrans new species (Figs. 19, 40, 70, 110; Plate 9)

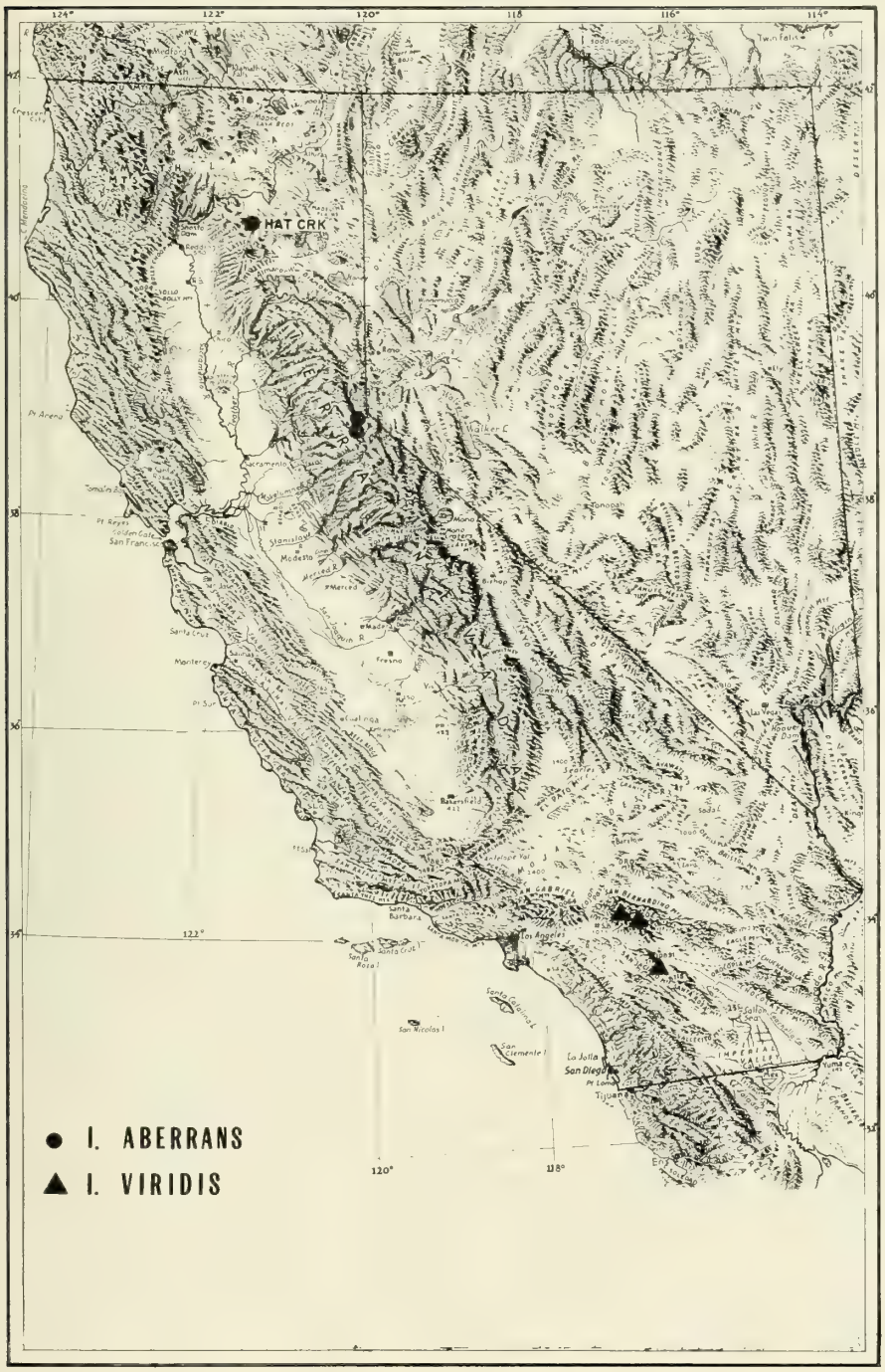
Type data. — Three labels, all handwritten. 1. "Hat Creek, Shasta Co., Ca., 1 October 1965." 2. "x-Nr. 6, U.V. Light trap." 3. "Coll. S. Seminoff."

Type locality. — The collector stated (personal communication) that the type was obtained from a "sticky foot" trap on the property of the U.S. Forestry station at Hat Creek.

Deposition of holotype. — The holotype is deposited in the California Academy of Sciences, No. 10,490, with the permission of the California State Department of Agriculture, Bureau of Entomology.

Diagnosis. — Size small for genus, form attenuate. Coloration of both sexes greenish, with two yellow parallel, dorsal longitudinal stripes continuous from vertex of head to abdominal apex. Males distinctive in following characters: tegmen pale yellowish brown; tergite ten (fig. 40) U-shaped mesad with lateral projections, without soft medial area; cercus with main shaft broadest basad, inner tooth broad, apex directed anteriorad; titillator (fig. 70) with base well developed, broad, concave on external margin, apex of arm expanded, distinctly recurved. Females may be distinguished by the following combination of char-

FIG. 19. — Known distribution of the *aberrans* Group.


HAT CRK
I. ABERRANS
I. VIRIDIS

acters: vertex of head laterally excavate; tergite ten with small V-shaped medial incision; sternite seven with prominent median tubercle (fig. 40); cercus straight, conical, subgenital plate incised for nearly one-half its length, latero-internal margin lip-like, apex truncate; ovipositor straight, longer than hind femur, weakly tuberculate, tuberculations restricted to margins rendering a serrated appearance. Color as in male, ventral surface of entire insect lavender in life. *I. aberrans* is an occupant of the coniferous community in the mountains of northeastern California (fig. 19).

Description. — HOLOTYPE MALE. Size small for genus, form moderately robust. HEAD with fastigium of vertex low, distinct, broad. Eyes moderately bulging, oval, slightly dorso-ventrally elongate; two and one-half times longer than width of first antennal segment. Third antennal segment half again as long as second. Antennae exceeding apex of hind femur for a distance of one-quarter the length of former. PRONOTUM smooth dorsad, distinctly, upturned in posterior one-quarter. Median carina distinct in posterior one-third, indicated only by color in median one-third. Anterior margin of pronotum even, not produced, posterior margin distinctly concave mesad. Posterior margin of lateral lobe broadly obtuse. Humeral angle of posterior one-third of pronotum distinct forming a vertical angle with lateral lobe; ventral margin of lateral lobe broadly obtuse, distinctly declivent anteriorad; anterior one-fifth of dorsum with distinct transverse sulcus, bowed posteriorad and obsolete in median portion; dorsum of disk with two short, broad sulci, one on each half of the disk forming a 45-50 degree angle with median carina which is nearly obsolete in that region. APPENDAGES. Hind femur protruding beyond apex of abdomen for a distance greater than half the length of femur (abdomen telescoped inward due to drying). Fore tibia unarmed dorsally on anterior margin. All femora without teeth on ventral margins. Plantula of hind tarsus short, reduced, stump-like, less than one-quarter length of metatarsus. Second tarsal segment only three-quarters as long as metatarsus. First and second tarsal segments longer than metatarsus. All legs distinctly pilose. ABDOMEN without dorsal medial carination. Tergite ten modified, U-shaped mesad with distinct lateral projections without indication of soft mesal area. Cerci projecting for one-quarter or less their length beyond apex of tergal projections. Cercus (fig. 40). Titillators of holotype possibly malformed. Both sides with base well developed (fig. 70), broad, concave on medio-lateral margin; right arm elongate, longer than base, dorso-ventrally flattened, with teeth as shown; apex expanded, slightly recurved. Arm of left portion of titillator with shaft only half as long as right portion, without teeth along its medial portion; apex of arm very flattened, the apical teeth truncate; it appears that the left portion is malformed. Subgenital plate with indistinct, shallow medial incision. Styles of subgenital plate short, knob-like, hardly distinguished from plate itself, much less in length than length of one side of medial incision. Cercus and external portions of subgenital plate pilose. COLORATION. General coloration pale yellow brown, likely faded from light green as indicated by the femora and tibiae which are pale green. Head and proximal quarter of antennae straw brown, eye ringed

with black. Eye reddish dark brown. Disk of pronotum brownish, darker along median carina. Humeral angle of lateral lobe with elongate stripe nearly parallel to lateral margin. Ventral margin of lateral lobe of pronotum with elongate, dull, creamish area ventrad to black stripe. All tarsi dark brown. Abdomen yellowish, darker brown in median portion forming an indistinct broad longitudinal stripe. This area expanded into large spots under the tegmina. Apex of all spines and inner tooth of cercus brown to black. Ventral surface of abdomen laterally dark brown, median longitudinal portion straw brown.

Holotype measurements. — Length: body, 15.00; pronotum, 4.70 × 3.40; left tegmen, 4.00; file, 1.80; fore femur, 5.50; fore tibia, 6.50; middle femur, 5.80; middle tibia, 6.90; hind femur, 15.00; hind tibia, 15.10. Titillator: right arm, 1.20; left arm, 0.95.

Although I am not absolutely certain at this time that the females described below represent the same species as the holotype, I include them here. They show similarities in color pattern, pronotal-femoral and tibial proportions and the vertex of the head is similar to that of the holotype. They are so very different from anything else seen in this study, except the related *I. viridis,* the other member of the *aberrans* Group, that they must belong here.

Description of female. — Size moderate for genus, form slender. Legs appearing longer than normal for genus. HEAD. Vertex well produced, laterally excavate. Third antennal segment two and one-half times longer than first. Eye moderately bulging, distinctly dorso-ventrally elongate. Eye two and one-quarter times longer than width of first antennal segment. PRONOTUM exactly as described for male. TEGMINA. Tegmen broad, well developed, nearly completely concealed by pronotum (Meyers Summit, El Dorado County, California) or protruding for a distance of one-third the dorsal length of pronotum (Emerald Bay, El Dorado County, California). APPENDAGES. Posterior femur protruding beyond apex of abdomen for a distance of one-third length of former. Spination of legs as described for male. ABDOMEN with weak indication of dorsal carina, mostly indicated by color. Abdomen with prominent median tubercle on sternite seven. Sternite seven elongate, much longer than basal width. Tergite ten with small V-shaped medial excavation. Cerci straight, conical, two and one-third times longer than basal width. Subgenital plate incised to nearly one-half its length, the latero-internal margins of incision lip-like, produced; apex nearly truncate, surface with raised longitudinal ridges suggestive of carinae. Ovipositor straight, longer than hind femur, without indication of lateral carinae at apex. Apex of ovipositor weakly tuberculate, these arranged at extreme apex on dorsal and ventral margins rendering ovipositor serrated. COLORATION. In life, basic ground color dark green. Head dorsally brownish, eye ringed with black. Eye brown, basal antennal segments purple. Palpi and labrum lavender. Pronotum dark green, humeral angles with black longitudinal stripe bounded ventrad by whitish indistinct area along posterior portion of lateral lobe. Legs green, at joints and foramina purple. Outer pagina of hind femur green, reddish brown dorsad. All tarsi purple; metatarsus

black in basal one-quarter on dorsal surface. Abdomen dark green dorsally except for dorso-medial portion which is reddish brown, this longitudinal stripe as broad as posterior border of pronotal disk and bounded laterad by two narrow, bright longitudinal stripes. Two brown and yellow stripes extend anteriorad on pronotal disk to region of anterior lateral sulcus where they are obsolete. Entire ventral surface of thorax and abdomen including sternal tubercle and subgenital plate lavender purple. Cerci reddish brown, clothed with whitish pile. Ovipositor reddish brown, tubercles darker brown. In death color somewhat faded, the purple becoming ferruginous.

Female measurements. — Meyers: body, 20.00; pronotum, 4.90 × 3.60; fore femur, 6.20; fore tibia, 7.60; middle femur, 7.00; middle tibia, 7.70; hind femur, 17.40; hind tibia, 17.30; ovipositor (apex missing), 18.40. Emerald Bay: body, 26.00; pronotum, 5.40 × 3.70; fore femur, 6.50; fore tibia, 8.00; middle femur, 7.10; middle tibia, 8.80; hind femur, 18.60; hind tibia, 18.70; ovipositor, 21.00.

Derivation of name. — This species is named with reference to its species group which contains species illustrating many features unique to most other members of the genus.

Seasonal occurrence. — The records suggest that this species occurs later in the season than most others of the genus. When I collected the specimen from the Meyers, El Dorado County, California, area I made an attempt to obtain additional material, especially males. Two hours of collecting failed to produce any further specimens. Since males are the first to die late in the season, it seems likely that the suggestion of a later than normal seasonal occurrence for *I. aberrans* may be an artifact of collecting.

Distribution. — *I. aberrans* is known from a few scattered localities (fig. 19) in montane northeastern California. It is apparently associated with the coniferous community.

Records. — CALIFORNIA: EL DORADO COUNTY: Emerald Bay State Park, Lk. Tahoe, 29, 30 August 1964 (C. D. Johnson, 1 ♀, DCR). Between Meyers and Echo Summit, Hwy. 50, 7,000 ft. elev. (D. C. Rentz, 1 ♀, DCR). SHASTA COUNTY: Hat Creek, Forestry prop., 1 October 1965 (S. Seminoff, 1 ♂, holotype, CAS).

Specimens studied. — three; holotype, two paratypes.

Hosts. — The Meyers specimen was collected at midday on a low fir (*Abies*) bough where it was sunning itself. The female was found three to four feet from the ground and was very well concealed due to its protective coloration.

Discussion. — *I. aberrans* combines several features which do not permit including it within any of the other recognized species groups

of the genus *Idiostatus*. The single male representative, upon which the name is based, lacks the black tegminal spot characteristic of the *aequalis* Group but possesses the dorsal projections of tergite ten which are found among species in that group. The titillators are not suggestive of the *californicus* Group, although the coloration might suggest possible relationship. The subgenital plate and short styles and development of tergite ten are similar to those seen in *I. fuscopunctatus* but the titillators and tegminal coloration vaguely resemble those which are seen in the *inyo* Group.

The females are equally distinctive. In body form, they resemble those of *I. aequalis* but there are no green forms known in that species group, nor any representatives with sternal tubercles. The tubercles of the ovipositor are arranged as serrations on the apex of that organ, a condition not found in the *aequalis* Group. The peculiar lip-like form of the subgenital plate is seen only in the *inyo* Group but not to the extreme degree illustrated by both representatives of the *aberrans* Group. No decticine with which I am familiar possesses the brilliant combination of colors as previously described. In death this soon fades to a nearly unicolorous straw brown. The light colored stripes on the dorsum of the living specimen's abdomen are barely visible on the preserved museum specimen.

The abdominal sternal tubercle characteristic of the *aberrans* Group is not unique among the Decticinae. Other genera with species sharing such a feature include: *Ateloplus, Clinopleura, Plagiostira, Zacycloptera* in the Nearctic region and *Sepiana* and *Yersiniella* in the Palearctic region. The character can be variously modified as in *Plagiostira gillettei* which has a single tubercle mesad on sternites six and seven, or *Sepiana sepium* which has paired tubercles on sternite seven. The function of the tubercles is uncertain, but curiously, males of most species observed with this character also possess dorsal projections of tergite ten as does *I. aberrans*. Perhaps during courtship the tubercles are stimulated by these projections in much the same fashion as is the entire ventral surface of the abdomen of the female by the abdominal projections of male *aequalis*, a species with dorsal projections but no tubercle. Other genera with similar dorsal projections such as *Eremopedes, Pediodectes, Oreopedes,* and *Inyodectes* also lack the abdominal tubercle.

The formation of the serrated ovipositor formed by the arrange-

ment of the tuberculations is unique with the *aberrans* Group. It is a well developed characteristic of all species of *Neduba* and among several undescribed species of the Chilean *Platydecticus*. Living in forest clearings or along the forest margins, *I. aberrans* may use the serrated ovipositor to protectively conceal the eggs in wood or other plant material.

Three collecting trips were made by the author to the type locality, two in 1968 and one in 1969, in order to obtain additional material. The area was searched both day and night on foot and by car. No specimens were found. Other decticines either heard or collected include: *Capnobotes* sp., singing at night high in pines; *Idionotus siskiyou* Hebard found near Hat Creek on the road at night; *I. inermis* (peculiar form with spatulate titillator — see discussion, *I. inermis*), found singing during the day in *Purshia tridentata*. The collector of the holotype was consulted and stated that the type was obtained in a Forest Service sticky foot trap used in bark beetle studied at the Experiment Station. He made an effort to collect more specimens but was unsuccessful.

The Meyers locality was revisited in 1966 and again in 1968 but no member of the genus *Idiostatus* could be found. The single female from this locality was collected in the Lodgepole Pine-Red Fir Belt as described by Storer and Usinger (1963:27). This area is mixed chaparral with fir and pine.

Idiostatus viridis new species (Figs. 19, 111: Plate 9)

Type data. — The type labels, single label, printed. 1. "Camp O-ongo, nr. Running Spgs., S. Bdno. Mts., Calif., 8-12 Aug. 1966, coll. C. L. Hogue."

Type locality. — The following information concerning the collection of the holotype has been supplied by the collector, Dr. C. L. Hogue of the Los Angeles County Museum of Natural History. The camp is located 2.6 miles northwest of Running Springs in the San Bernardino Mountains, on an west-east ridge separating two minor tributaries of Deep Creek. This stream eventually flows into the Mojave River in Antelope Valley. The elevation of the lodge, where the holotype was collected, is 6,200 feet. Map coordinates are 117 degrees 07′ 31″ W by 34 degrees 13′ 40″ N.

Deposition of holotype. — The holotype is deposited in the Los

Angeles County Museum of Natural History.

Diagnosis. — Known only from females. Size medium for genus, form attenuate. Coloration dark green dorsally with two longitudinal, parallel, yellow stripes; venter purplish or lavender. Females distinctive in following characters: lateral portions of fastigium concave; tergite ten with narrow medial incision, latero-apical margins acutely produced; sternite seven (fig. 111) with median tubercle; subgenital plate with base broader than apex, latero-internal margins little produced, apex truncate; cercus conical, densely tuberculate, distinctly directed inward; ovipositor straight, longer than hind femur, tubercles confined to dorsal and ventral margins. *I. viridis* is an occupant of the Yellow Pine Belt and coniferous community of the mountains of southern California (fig. 19).

Description. — HOLOTYPE FEMALE. Size medium for genus, form slender. HEAD with fastigium of vertex low, distinct, broad. Sides of fastigium slightly concave. Dorso-lateral margin of fastigium broadly rounded, without distinct knob. Third antennal segment distinctly longer than second. Second antennal segment half again as long as first. Eye situated high atop head, distinctly dorso-ventrally elongate, one and one-third times longer than first antennal segment. Antennae barely attaining apex of ovipositor. PRONOTUM moderately smooth dorsad, deplanate. Median carina only barely indicated on posterior one-sixth, indicated only by color on anterior five-sixths. Anterior margins of pronotum slightly produced laterad, concave in dorso-medial area; posterior margin truncate, slightly concave in median portion. Posterior margin of lateral lobe convex, becoming concave and undulant ventrally; ventral margin rather narrowly obtuse (holotype) to straight, even (paratype, Idyllwild, California). Anterior one-fifth of dorsum of pronotum with distinct undulant transverse sulcus, obsolete in dorso-median region. Disk of pronotum with two short, broad sulci, one on each half of disk in 45-50 degree angle with median stripe of pronotum. TEGMINA broad, nearly completely concealed by pronotum (type) to protruding for a distance of one-third their length (paratype, Idyllwild, California). APPENDAGES. Hind femur protruding beyond apex of abdomen for a distance of one-third the length of femur. Fore tibia unarmed on dorsal anterior margin, posterior margin with three widely spaced spines; apex of dorsal margin of hind femur with two slender apical spurs, hardly distinguishable from adjacent spines. Inner spur distinctly uncinate, outer spur straight. Ventral surface with four short, slender apical spurs, the inner pair reduced, uncinate, three-quarters the length of the outer spurs. All femora without teeth. Plantula of hind tarsus distinct, broader than long, stump-like, less than one-quarter length of metatarsus. Second tarsal segment nearly as long as first. All legs distinctly pilose. Abdomen with only slight indication of median dorsal carina, with distinct tubercle in median of sternite seven. Sternite seven broad, anterior margin distinctly V-shaped. Tergite ten with narrow medial excavation, latero-apical margins acutely produced, not finger-like. Cercus rather conical, three times longer than basal width, rather densely tuberculate, distinctly curved inward; surface clothed with long

pile. Subgenital plate with base slightly broader than apex, only slightly longer than basal width, lateral basal portion concave; median incision attaining half its length, latero-internal margins hardly, if at all, produced; apex truncate, inner apical margins of median incision acute; surface sparsely rugulose. Ovipositor straight, longer than hind femur, without indication of lateral carinae at apex; tubercles at apex few in number, almost wholly confined to dorsal and ventral margins rendering a serrated appearance. COLORATION. Unknown for living individuals, likely very similar to that described for *I. aberrans.* Color of type seemingly well preserved. Basic ground color rich dark green. Head dorsally brownish, eye ringed with black. Eye dark brown, basal antennal segments purple to light brown, palpi and labrum light brown (likely lavender in life). Pronotum dark green, humeral angles with narrow black longitudinal stripe bounded ventrally by whitish area with yellow overcast along lateral and ventral margins of lateral lobe of pronotum. Legs green, at joints and foramen purple. Outer pagina of hind femur green, dorsally with slight yellowish cast. All tarsi purple; metatarsus black in basal dorsal portion. Tegmen purple in anterior lateral portion, medial lateral portion with veins dark black. Abdomen dark green except for dorso-medial portion which is mostly green but with some brown. This is more prominently brown on disk of pronotum. Dorsum of abdomen with two distinct, longitudinal yellow stripes continuing from anterior margin of pronotum to abdominal apex. Entire ventral surface of thorax and abdomen light purple. Cerci reddish brown, darker at apex, clothed with white pile. Ovipositor reddish brown, tubercles darker, apex black.

Holotype measurements. — Length: body, 20.00; pronotum, 5.30 × 3.60; fore femur, 5.70; tibia, 7.00; middle femur, 6.60; tibia, 7.40; hind femur, 17.80; tibia 16.20; ovipositor, 19.50.

Variation. — Little structural variation is noted among the four females studied here. The specimens from Barton Flats, San Bernardino County, California, appear to have the legs slightly longer in proportion to the body length. The only specimen in which the color is well preserved is the holotype. The specimen mentioned above was not stuffed with cotton after death and as a result the green has faded to light brown. The dorsal stripes are still faintly visible. The specimen from Idyllwild, Riverside County, California, was once preserved in alcohol, the green having been completely lost and the darker portions becoming purple, typical of such preservation. The two dorsal stripes are distinct but have become white in color.

Derivation of name. — This species is named in recognition of its color which is distinctive for the two species of the *aberrans* Group.

Seasonal occurrence. — The four females were taken between 8 August (type locality) and 11 September (Idyllwild, Riverside County, California).

Distribution. — *I. viridis* is known only from the San Bernardino Mountains, San Bernardino County, California, and Idyllwild in the

San Jacinto Mountains of Riverside County, California.

Records. — CALIFORNIA: RIVERSIDE COUNTY: Idyllwild, 6,000 ft. elev., 11 September 1962 (E. I. Schlinger, 1 ♀, UCR). SAN BERNARDINO COUNTY: Barton Flats, 22 August 1936 (no collector, 1 ♀, LACM). Camp O-ongo, nr. Running Sprs., San Bdno. Mts., 8-12 September 1966; 29 August 1970 (C. L. Hogue, 1 ♀, holotype, LACM).

Specimens studied. — four; holotype, three paratypes.

Discussion. — *I. viridis* is closely related to *I. aberrans.* Only collection of males will enable certain placement. The species doubtlessly occurs with *I. aequalis* and possibly with *I. fuscopunctatus,* although it may be ecologically separated from these species. The collector of the type states (personal communication) that the type locality is situated in the Yellow Pine Community with white fir, *Abies concolor;* big cone pine, *Pinus coulteri;* sugar pine, *P. lambertiana;* incense cedar, *Libocedrus decurrens;* and California black oak, *Quercus kelloggii,* in abundance in addition to the more common namesake of the community, Western yellow pine, *Pinus ponderosa.* That the species is apparently rare is attested to by the fact that so few specimens have been collected in an area of rather intense entomological collecting activity.

I. viridis, like its relative *I. aberrans* is a peculiar member of the genus. The shape of the pronotum, the straight ovipositor, spination of the legs and attenuate body shape tend to relate these species more to the species of the *aequalis* or *inyo* Groups. However, the green coloration and apparent ecological preference for conifer forests show relationships with members of the *californicus* Group. Until males can be associated, its exact status will remain uncertain. No information is yet available concerning the activity patterns of this species, either with regard to mating or stridulation.

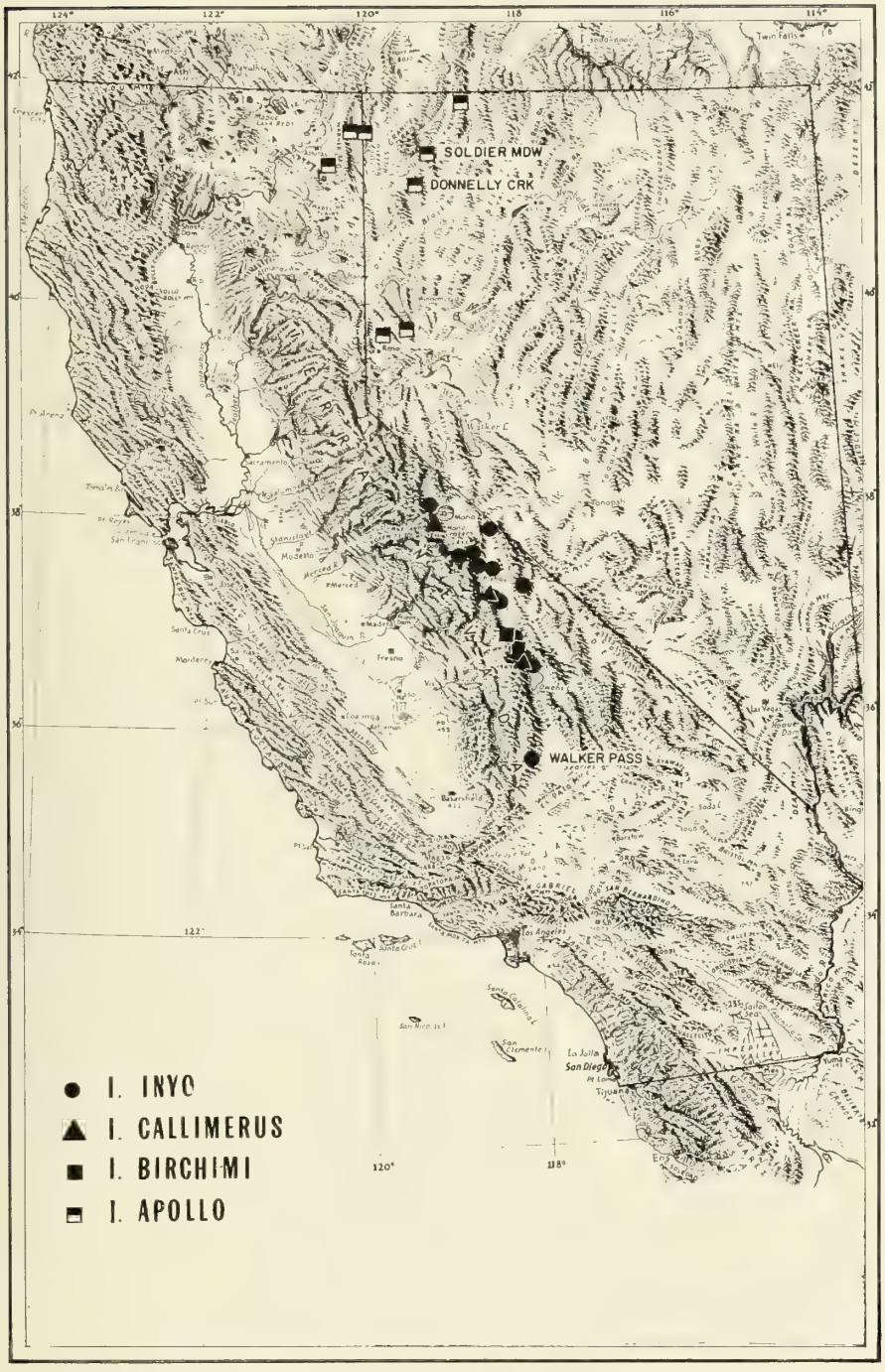
The three paratypic females are placed here with a considerable degree of confidence. The female from Barton Flats, California, not far from the type locality, is much like the holotype except that the color is faded due to lack of proper preservation. The female from Idyllwild, California, is also very likely this species even though it is from such a widely disjunct locality. Its color is predominantly purple now due to original preservation in alcohol. It does retain the dorsal longitudinal stripes, now faded to white, and the characteristic sternal tubercle and peculiar shape of the subgenital plate. The ovipositor

is also as described for the holotype. The collector of this specimen, Dr. E. I. Schlinger, recollects that its capture was near a summer cabin in the Happy Valley section of Idyllwild. The area is a coniferous forest much as described for the Camp O-ongo area with perhaps more chaparral influence. Dr. Schlinger recalls that he caught the specimen on or hiding under the "false bark" front of the cabin. His interest in finding such a strikingly marked individual prompted him to search for more but these efforts were not rewarded.

The *inyo* Group

Members of the *inyo* Group (*I. apollo, I. birchimi, I. inyo, I. callimerus*) are moderate to small sized, nocturnal in habit, and chiefly associated with chaparral vegetation. In body form, all but a single known species are streamlined, attenuate insects, well suited for a thamnophilous habit. The single exception is *I. callimerus,* a short, robust species which lives either on the ground or close to it. The species of the *inyo* Group are most closely related to those of the *aequalis* Group and differ chiefly in lacking the characteristic black apical spot of the tegmen. Since this character is often poorly developed in females, some difficulty may be encountered in placing single representatives of that sex into the proper species group unless more than one character is used. A good example is provided by *I. fuscopunctatus* and *I. callimerus.* These two species co-exist in rather similar ecological conditions and as a result there is considerable degree of convergence in gross morphological features (ovipositor, pronotum, tegmina, and overall body form). This is only true of the females, however, since the males are strikingly different regarding the structure and coloration of tegmen, abdominal tergite and cerci. Other morphological features peculiar to the *inyo* Group may be found in both tegminal structure and coloration. Males of *I. callimerus* possess a relatively long tegmen (tegmen-pronotum ratio, Table 7). Both *I. apollo* and *I. birchimi* exhibit a contrastingly marked tegmen, the veins being light straw brown, the cells either black (*I. apollo*) or tannish brown (*I. birchimi*). The tegmina of *I. inyo* are uniform reddish brown. This latter species is the sole known member of the species group possessing tergal projections of abdominal segment ten. Whether they are used in courtship activity has not been determined.

FIG. 20. — Known distribution of the *inyo* Group.


SOLDIER MDW
DONNELLY CRK
WALKER PASS
I. INYO
I. CALLIMERUS
I. BIRCHIMI
I. APOLLO

All species of this group are restricted to northwestern Nevada and adjacent California, south to the southeastern slopes of the Sierra Nevada Mountains. With the exception of the nominate species and perhaps the relatively little collected *I. callimerus,* other species tend to be among the rarest of tettigoniids one encounters during a summer evening's collecting. This peculiarity has resulted in two of the four species being unknown until recently.

Idiostatus apollo new species (Figs. 20, 41, 71, 100, 101; Plate 7)

Type data. — Two labels, both printed. 1. "Calif., Modoc County, 7-9 mi. E., Cedarville on Hwy. 299, 4,700 ft., 10 July 1969. David C. Rentz." 2. "Matured 15 July 1969."

Type locality. — The type locality is along California State highway 299 (in Nevada the same road is numbered 8A) to Vya, Nevada. The type specimen was found near the east shore of Middle Alkali Lake.

Deposition of primary types. — The holotype and allotype are deposited in the California Academy of Sciences, number 10,491.

Diagnosis. — Size very small for genus, form attenuate. Coloration pale, usually brown but often grey (Plate 7). Males distinctive in following characters: tegmen with veins whitish, cells black; stridulatory vein conspicuously swollen basad; tergite ten without dorsal projections (fig. 41), median portion soft, not membranous, without pile; cercus (fig. 41) elongate, shaft straight to weakly bowed inward, of uniform width throughout; inner tooth of cercus placed in apical one-quarter, stout, titillator (fig. 71) fused at base, arm straight or divergent with broad, short serrations on distal one-half. Females may be identified by the following characters: tergite ten with poorly defined but distinct V-shaped incision; cercus elongate, conical, straight; sternite seven with poorly defined median tubercle; subgenital plate (figs. 100, 101) as long as broad, median incision extending to a depth of at least one-half the plate itself; ovipositor as long as or slightly shorter than hind femur, weakly upcurved, without tuberculation, apex of dorsal and ventral valves carinate. *I. apollo* is an occupant of the Saltbush-Greasewood community of northern Nevada and adjacent California (fig. 20).

Description. — HOLOTYPE MALE. Size small for genus, form attenuate. HEAD with fastigium of vertex well produced, especially dorsad, attaining a height equal to length of first antennal segment. Vertex barely twice as wide as first antennal segment. Eyes prominent, somewhat reniform, prominently bulging, half again as long as broad. Second antennal segment subequal to first, equal in length to third. First antennal segment two and one-quarter to two

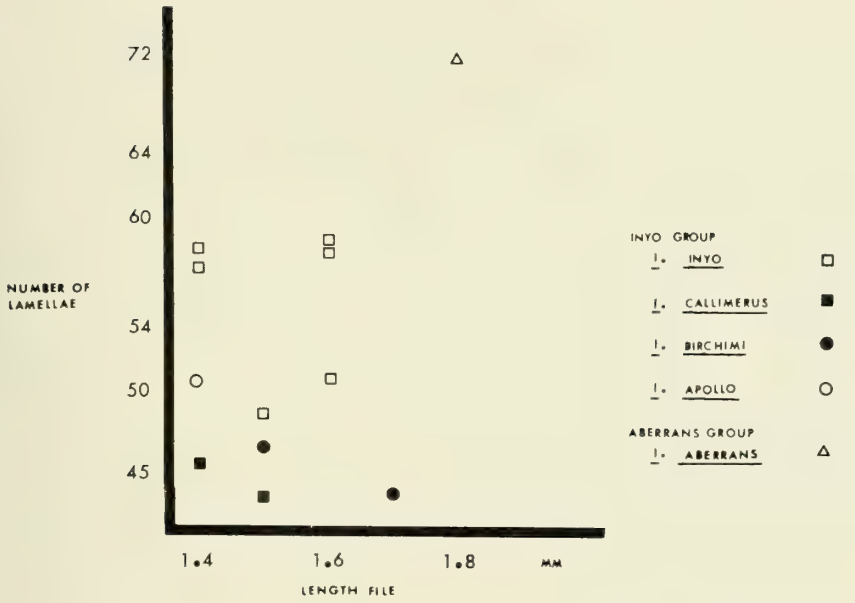


TABLE 5. — Scatter diagram of lamella number plotted against file length for left male stridulatory file.

and one-half times broad as second, excavate mesad. Flagellum of antenna very thin, thread-like, slightly exceeding apex of hind femur. Frons and genae smooth, sparsely pilose. PRONOTUM moderately deplanate dorsad; in lateral view, dorsal outline with narrow excavation in distal one-third, without medial carina and, if present, only indicated by color; anterior margin broadly undulant, concave mesad; posterior margin truncate, distinctly concave mesad; posterior one-third of dorsum with broad but distinct humeral angle; anterior margin of lateral lobe broadly sloping distad, posterior margin declivent with distinct medial sinus; ventral margin of lateral lobe broadly obtuse; anterior one-fifth of surface with transverse sulcus, broadest and deepest development in humeral area, obsolete on pronotal disk, continuous to mesad of lateral lobe. TEGMINA. Tegmen protruding for a distance of one-third or less than dorsal length of pronotum; right margin broadly acute anteriorad, undulant to apex; left margin broadly obtuse, expanded, fan-shaped to apex; veins prominent, heavy, not net-like at apex; stridulatory vein conspicuously swollen on basal one-half. APPENDAGES. Legs of slightly longer than normal length for genus. Fore femur slightly longer than dorsal length of pronotum. Apex of abdomen attaining apical one-quarter of hind femur. Proximal segment of hind tarsus elongate, longer than next two combined; plantula well indicated, broad mesad, apex acute. ABDOMEN dorsally smooth, carina indicated only by color; surface smooth, with widely scattered short, stout setae. Tergite ten

without dorsal extensions; median portion soft, not membranous or differently colored, without pile. Tergite ten subequal in length to tergite eight, twice as long dorsally than tergite nine. Cercus (fig. 41) elongate. Subgenital plate longer than broad; medial incision shallow, indistinct, styles short, stump-like (holotype), elongate, longer than interstylar distance (paratype). Titillator (fig. 71) fused at base (holotype) to slightly separated (paratype). COLORATION. Overall coloration pale straw brown, very similar to that described for *I. birchimi.* Disk of pronotum and dorsum of abdomen lighter than lateral lobes or lateral portions of abdomen. Eye mottled grey, not ringed with black. Frons and first two antennal segments cream color, densely marked with purple speckles. Flagellum of antenna light straw brown. Pronotum contrastingly marked, lighter on disk than on lateral lobes. Lateral extremities of anterior pronotal sulcus dark brown. Surface of pronotum with dark brown or purple speckling. Ventral portion of lateral pronotal lobe with broad light posterior region continuous ventrad to anterior portion of the lobe. Tegmen with veins light straw brown, the cells between the veins dark black. Thorax and side of abdomen nearly unicolorous with lateral pronotal lobes. Posterior margin of each abdominal segment with many dark spots, the lateral spots larger and fewer in number than those on dorsal surface. Legs concolorous with body. Outer pagina of hind femur dark, without dark stripe. Setae of legs and cerci brown; spines black basad, light straw brown mesad, darker brown or black in distal one-third. Plantula of hind tarsus uniform dark brown. Tarsal segments concolorous with predominant body color, third segment darker, slightly lighter in color than other segments. Sides of abdomen and pronotum unicolorous as in *I. birchimi,* the dorsum contrastingly lighter forming a broad dorsal stripe extending from vertex of head to abdominal apex.

Holotype measurements. — Length: body, 16.00; pronotum, 4.30 × 2.70; fore femur, 4.10; fore tibia, 4.90; middle femur, 4.90; tibia, 5.30; hind femur, 13.70; tibia, 13.40.

ALLOTYPE FEMALE. Similar to male but with following exceptions: size slightly larger. Tegmen protruding beyond apex of pronotum one-sixth to one-tenth the dorsal length of pronotum. Tergite ten with poorly defined but distinct broad V-shaped incision. Cercus elongate, conical, straight, three times longer than basal width. Sternite seven with low, ill-defined median tubercle. Subgenital plate nearly as long as broad, medial incision broad, extending for a distance of at least one-half the plate itself. Ovipositor shorter than hind femur, slightly upcurved. Tuberculations of ovipositor absent, the dorsal and ventral margins very slightly notched. Latero-medial surface of apical one-sixth to one-eighth of dorsal and ventral valves of ovipositor distinctly carinate. Coloration of female exactly as described for male except ovipositor darkened at extreme apex, the apical one-fifth slightly infuscate dorsad and ventrad.

Allotype measurements. — Length: body, 17.60; pronotum, 4.50 × 2.50; fore femur, 4.90; tibia, 6.00; middle femur, 5.40; tibia, 6.90; hind femur, 15.50; tibia, 15.50; ovipositor, 14.60.

Variation. — The two male specimens show little morphological variation

but there is a considerable difference in color. The holotype is distinctly darker than the other male, although the original color pattern is retained. Females may have the ovipositor as long or slightly shorter than the length of the hind femur. Some of the smaller females (Denio, Soldier Meadows, Nevada) have the ovipositor weakly but distinctly upturned. Table 8 shows size variation which is most notable among females with regard to the length of the ovipositor.

Chromosome number. — 2N = 29. A male collected east of Cedarville, California, had the following chromosome complement: 2V + 26R + XR = 29.

EGGS. — Eggs from a female collected west of Cedarville, Modoc County, California, agreed with number 79 (light grey yellow brown) on the ISCC-NBS color chart. A female from the same locality laid 36 eggs in captivity between 16 September and 1 October 1968. Egg measurements, Table 9.

Derivation of name. — This species is named in recognition of one of the most historic events of mankind, the flight of Apollo XI and the subsequent first steps of man on the moon. This occurred on July 19, 1969 shortly after one of the paratypes (Happy Valley) was collected.

Seasonal occurrence. — *I. apollo* was collected as a last instar nymph at Soldier Meadows, Nevada, on 10 July 1969 and matured 15 July of that year. The latest adult record is for a female from near Bald Mountain summit, Nevada, collected 26 September 1969.

Distribution. — *I. apollo* is primarily an occupant of the Saltbush-Greasewood Community. The species is found from northeastern California and adjacent northern Nevada, south along the eastern slope of the Sierra Nevada Mountains to the vicinity of Reno, Nevada. Altitudinally, the species has been found between 4,400 and 6,800 feet elevation. The eastern distributional limits of *I. apollo* are still unclear (fig. 20).

Records. — CALIFORNIA: MODOC COUNTY: Cedarville, 1 mi. W., 5 September 1968 (D. C. Rentz, 1 ♀, DCR); 2.5 mi. W., 4,800 ft. elev., 5 September 1968 (D. C. Rentz, 1 ♀, DCR); 7 mi. E., 5 September 1968 (D. C. Rentz, 1 ♀, DCR); 7-9 mi. E. on Hwy. 299, 4,700 ft. elev., 10 December 1969, matured 15 July 1969 (D. C. Rentz, 1 ♂, holotype, CAS); same date, matured 22, 23 July 1969 (D. C. Rentz, 3 ♀♀, CAS, DCR, including allotype). Likely, 1 mi. E., 5 September 1969 (A. B. Gurney, D. C. Rentz, 1 ♀, dead on road, DCR). NEVADA: HUMBOLDT COUNTY: Denio, 1.5-4.5 mi. W. on Hwy. 140, 4,500 ft. elev., 18 July 1968 (D. C. Rentz, 1 ♀, DCR). Soldier Mdws., 15 mi. W. Pahute Pk., 4,400-4,500 ft. elev., 16 July 1968, matured 20 July 1968; 8 July 1969, matured 17 July 1969 (D. C. Rentz, R. C. Bechtel, P. C. Martinelli, 2 ♀♀, DCR). Donnelly Creek (2.4 mi. W. Parman Ranch), 4,500 ft. elev., 11 July 1969 (R. C. Bechtel, P. C. Martinelli, 1 ♂, 3 ♀♀, DCR, NSDA).

WASHOE COUNTY: Bald Mtn. summit, 6,800 ft. elev., 26 September 1969 (R. C. Bechtel, 1 ♀, NSDA). Happy Valley (Reno), 19 July 1969, matured 20 July 1969 (D. C. Rentz, R. C. Bechtel, 1 ♀, DCR). Little Valley, 30 July 1968 (M. A. Bechtel, D. L. Horton, 3 ♀♀, NSDA). Pyramid Lk., 7 August 1966 (W. J. Turner, 1 ♀, DCR). Questionable placement: Reno, Stead Airforce base, 11 August 1967 (D. C. & K. A. Rentz, 1, 4th instar ♂, DCR).

Specimens studied. — 19, holotype, allotype, 16 paratypes.

Hosts. — At Soldier Meadows, Nevada, individuals of *I. apollo* were found after dark approximately two and one-half feet from the ground on greasewood. At Happy Valley, near Reno, Nevada, the single female was caught when a small *Atriplex* bush was trampled during midday. R. C. Bechtel and P. C. Martinelli found a series of *I. apollo* by similarly trampling bushes of *Atriplex* sp. during the day at Donnelly Creek, Nevada. On other occasions I found the species on road surfaces at night.

Discussion. — *I. apollo* is the northern counterpart of *I. birchimi* which it closely resembles but differs in its smaller size, shorter ovipositor in proportion to body length, black tegminal cells and different male terminalia. I have not found it co-existing with *I. birchimi* but the Mono Lake vicinity and points south should be checked to determine is either species is found there.

As with *I. birchimi, I. apollo* appears to be rare. As indicated by the records, I have not been able to collect a sizeable series of the species at any time even though I have found it in the nymphal stage. *I. apollo* is known from a considerably broader geographic range than many other more common species and its absence in general collections is a reflection of its rarity.

I. apollo occurs sympatrically and apparently synchronically with many other decticines, including several species of *Idiostatus.* At Denio, Nevada, *I. apollo* was collected at night in the last instar stage, on the highway with the diurnal *I. inermoides* and the nocturnal predator, *Capnobotes fuliginosus. I. inermoides* was taken either as adults or late instars. The latter species far outnumbered *I. apollo,* only a single female of which was found. At Soldier Meadows, Nevada, under similar ecological conditions (Saltbush-Greasewood Community), we found *I. apollo* often in the same bush with the diurnal, aggressive *I. bechteli.* Also in the same plant *Capnobotes occidentalis* could be found. At Cedarville, California, on the east slopes of the Warner Mountains, all of the specimens from west of that town

were collected at the margin or ecotonal area between the Conifer forest and Sagebrush communities on the road surface at night. East of Cedarville, California, near Middle Alkali Lake, I not only found immature *I. apollo* on the road surface at night in the Greasewood-Saltbush Community but also living with adults of *I. martinellii, Steiroxys* sp., and *Capnobotes occidentalis.* During the preceding dry years *I. martinellii* was not found.

I. apollo must compete with other decticines for food and mating space. Its small size and nocturnal habits likely preclude hybridization with the above species although in the southern portion of its range, it may come into contact with the slightly larger and similarly nocturnal *I. aequalis* and *I. inyo.*

I. apollo is a nocturnal species, singing, feeding and apparently mating at night. During the day, individuals may be found in bushes where they hide from predators and the hot sun. The small size of this species would seemingly render exposed individuals vulnerable to large robber flies, species of which were seen frequently at nearly all localities. Males sing with a very low buzz, only at night. Both sexes wander freely at night, feeding on plant and animal matter. Females oviposit at this time. Mating of *I. apollo* has not been observed and details of courtship are still unknown.

To the casual observer, *I. apollo* might be mistaken for a species of *Oreopedes.* However it is rather easily separated from "eremopedioid" stock on the basis of the characters listed in Table 1. Pronotal and tegminal characteristics as well as the abruptly upcurved ovipositor, show similarities with *Oreopedes* but a combination of characters places *I. apollo* in the genus *Idiostatus.*

Idiostatus birchimi new species (Figs. 20, 42, 72, 73, 102; Plate 7)

Type data. — Four labels, all printed. 1. "Calif. Inyo Co., 11 mi. West Lone Pine, 6 July 1961." 2. "ex: *Eriogonum.*" 3. "D. C. Rentz collector." 4. "File 1.8 mm, teeth 48, 26.6 T/mm, det. D. C. Rentz, 1969."

Type locality. — The type locality is approximately 9-11 miles west of Lone Pine on the Whitney Portal road. This is a well known locality to orthopterists with the decticines *Idiostatus inyo, Ateloplus hesperus, Neduba ovata gigantea, Neduba macneilli, Capnobotes occidentalis, C. fulginosus* and *C. arizonensis* all occurring in the same

general vicinity. See Rentz and Birchim (1968) for a discussion of this large number of species recorded from a small area in the Owens Valley. The exact area from which the type series was collected is approximately one-half mile east of where the road commences the steep grade to Whitney Portal.

Deposition of primary types. — The holotype and allotype are deposited in the California Academy of Sciences, number 10,492.

Diagnosis. — Size medium for genus, form moderately attenuate. Coloration usually brownish, ventral surfaces of hind femora often blue-green. Males distinctive in following characters: tegmen brownish, veins lighter, cells brown, not black; stridulatory veins moderately swollen basad; tergite ten (fig. 42) not modified, truncate distad; cercus (fig. 42) dorso-ventrally flattened, twice as long as basal width, subapical tooth stout in distal one-third; titillator (figs. 72, 73) with base well developed, arm attenuate, bulbous basad, gently undulant with small number of teeth in distal one-third. Females may be identified by the following characters: tergite ten with poorly defined median sulcus, apices not produced; cercus stout, straight, without curvature, apex blunt; subgenital plate as broad as long, deeply incised for a distance at least half the length of plate; ovipositor shorter than hind femur, tuberculation reduced, dorsal and ventral valves carinate at apex. *I. birchimi* is an occupant of the Juniper-Pinyon Woodland community of the southeastern slopes of the Sierra Nevada Mountains of California (fig. 20).

Description. — HOLOTYPE MALE. Size medium for genus, form intermediate between robust and attenuate. HEAD with fastigium of vertex low, broad, hardly produced dorsad. Vertex one and one-half times broader than width of first antennal segment. Eyes prominent, large, moderately bulging, ovoid, dorso-ventrally elongate. Eye more than twice as long as length of first antennal segment. Second antennal segment nearly as long as first, one-third as broad. Third antennal segment slightly longer than second, less than half as long as first. Antenna surpassing hind femur. PRONOTUM deplanate dorsally, without any indication of median carina; anterior margin concave mesad; posterior margin of pronotum slightly undulant, broadly concave in medial ventral portion; ventral margin of lateral pronotal lobe nearly truncate, but slightly declivent anteriorad. Anterior one-fifth of dorsum of pronotum with shallow, transverse, undulant sulcus directed posteriorad in median area where it is obsolete; surface of lateral lobe where transverse sulcus originates distinctly depressed. TEGMINA protruding beyond apex of pronotum for a distance of three-quarters the dorsal length of pronotum. APPENDAGES. Legs of normal length for genus. Fore femur slightly longer than pronotum. Apex of abdomen attaining mid hind femur or slightly beyond. Plantula of hind tarsus prominent, well developed, slightly less than half the length of metatarsus. ABDOMEN with weak indication of median carina, but this indicated mostly by color; surface mostly smooth, lightly pilose. Tergite ten not modified, smooth

dorsally; some specimens show a slight medial sulcus due to deformation in drying. Cercus (fig. 42) dorso-ventrally flattened. Titillator (figs. 72, 73) with base well developed. Subgenital plate elongate with indistinct medial incision; style elongate, half again as long as length of one side of medial incision. Subgenital plate pilose on external surface. COLORATION. Overall coloration pale straw brown. Eye dark reddish brown, not ringed with black. Antenna with all segments unicolorous. Legs with femora darkened dorsally. Outer pagina of hind femur without indication of stripe. Plantula dark brown, margins black. Pronotum with lateral lobes darker than dorsum of pronotum. Dorsum of pronotum with two discontinuous white stripes laterad, separating light color of dorsum of pronotum from darker lateral lobes. Ventral and posterior margins of lateral lobe of pronotum with broad white area. Tegmen with veins cream to straw brown, membrane brownish. Abdomen darker laterally than dorsally, the darker portions resembling "brushmarks." All spines light straw brown basad, black apicad. Pile of body golden brown. Dorsal surface of metatarsus black.

Holotype measurements. — Length: body, 18.00; pronotum, 4.50 × 3.10; fore femur, 4.50; tibia, 5.50; middle femur, 5.30; tibia, 6.20; hind femur, 17.50; tibia, 16.20; tegmen, 4.80; file, 1.80 with 48 teeth; right arm of titillator, 1.50.

ALLOTYPE FEMALE. Female similar to male with following exceptions: size slightly larger. Tegmen protruding beyond apex of pronotum for a distance of slightly less than one-third the dorsal length of pronotum. Tergite ten with poorly defined median sulcus, apices not produced. Cercus stout, straight, without curvature, less than twice as long as basal width; apex blunt. Entire cercus clothed with long pile. Subgenital plate as broad as long, deeply incised, for a distance of at least half the length of plate itself. Ovipositor distinctly shorter than hind femur, noticeably uncurved. Tuberculation of ovipositor extremely reduced, indicated solely as low, irregularly spaced serrations on the dorsal and ventral margins of apical one-fifth of that organ. Dorsal valve of ovipositor carinate laterad at apex, the carina also with low serrations. Ventral ovipositor valve with low apical carination, less developed than dorsal carina. Coloration of body and appendages as described for male. Ovipositor concolorous with basic body color except at apex where the serrated portion is dark brown, the extreme apex black.

Allotype measurements. — Length: body, 19.00; pronotum, 4.80 × 3.10; fore femur, 4.90; tibia, 6.20; middle femur, 6.10; tibia, 7.20; hind femur, 20.10; tibia, 20.50; ovipositor, 26.60.

Variation. — Structural variation occurs in the degree of development of the outer tooth of the cercus of the male. The length of the arm of the titillator is also somewhat variable as is the degree of serration of the outer margins. Some males have the teeth only at the apex, others have teeth along the entire apical one-quarter of the titillator arm. Coloration is remarkably constant among the specimens studied, although three females have a distinct green overcast on all legs and tarsi. In each specimen the sides of the abdomen are darker than the dorsum, these two broad stripes continued on to the pronotal lobes and head.

Variation is noted in the intensity of the stripes, some specimens being quite pale in this regard.

Derivation of name. — *I. birchimi* is named after my colleague, the late James D. Birchim, whose enthusiastic interest in this group of insects commenced at an early age. He greatly aided the author in collecting and observing these insects.

Seasonal occurrence. — Last instar nymphs and teneral adults were collected at the type locality on 6 July 1961. The latest records for adults, both sexes, are 24 August 1965.

Distribution. — *I. birchimi* is known from Lone Pine, California, north to Independence on the east slope of the Sierra Nevada Mountains. It is an occupant of the Juniper-pinyon woodland community. Similar ecological situations occur to the north (west of Big Pine) and to the east (Westgard Pass vicinity). These areas were searched intensively, though unsuccessfully, at several different times and seasons during the 1960's.

Records. — CALIFORNIA: INYO COUNTY: Independence, 6 mi. W., 25 July 1965 (D. C. Rentz, 1 ♀, DCR); 20 August 1965 (J. D. Birchim, 1 ♂, 1 adult gynadromorph, DCR); 24 August 1965 (J. D. Birchim, 1 ♂, DCR). Lone Pine, 9 mi. W., base of Mt. Whitney, 4, 5 August 1931 (E. R. Tinkham, 1 ♀, ANSP); 6 mi. W., 23 July 1965 (D. C. Rentz, 1 ♀, DCR); 9 mi. W., 6 July 1961 (D. C. Rentz, 1 last instar ♂, DCR); 11 mi. W., 6 July 1961 (D. C. Rentz, 1 ♀, 1 ♂, holotype, allotype; 1 last instar ♀, CAS, DCR); 22 July 1964 (D. C. & K. A. Rentz, 1 ♀, DCR); 21 July 1965 (D. C. Rentz, 2 ♂ ♂, DCR).

Specimens studied. — 13, holotype, allotype, 11 paratypes.

Hosts. — *I. birchimi* has been collected at the type locality feeding on the mature flowers of *Eriogonum fasciculatum* and *Chrysothamnus* sp., and at the Independence locality on *Purshia tridentata.*

Discussion. — *Idiostatus birchimi* was discovered midway in the investigation of the genus by the author and his colleague James Birchim. The species is known from only two localities and it is doubtful that it extends much farther north or south of the two areas where it has been taken, since much effort has been made to locate it elsewhere.

This species is nocturnal and sympatric with *I. inyo,* the two often occurring on the same plant. The courtship and mating behavior have not been observed.

I. birchimi has not been found as abundantly as *I. inyo* at either

the Lone Pine or Independence locality. This close association with the more common *inyo* may account for its being overlooked for so many years even though the type locality is well known to orthopterists. Had a male been collected by E. R. Tinkham instead of a female (see records), he would likely have described this new species many years ago. Due to the overall similarity of size and coloration, his specimen was determined by Hebard as *I. inyo*. A most interesting study would be to determine if any ecological differences exist between the two species. In addition, studies involving courtship and mating behavior would undoubtedly reveal some differences between the species.

The closest relative of *I. birchimi* is *I. apollo* which occurs north of this species. *I. birchimi* is larger and differs in the shape of the cercus and titillator and curvature of the ovipositor. The color of the cells of the tegmina is brown in *I. birchimi,* black in *I. apollo*. Both species possess very similar color phases and occur under similar conditions. As yet there is no evidence that the two species occur sympatrically.

There was considerable uncertainty in correctly associating the females of *I. inyo* and *I. birchimi,* but was readily determined when Birchim found a bilateral gynandromorph. This remarkable specimen possesses male characters on the right side of its body, female characteristics on the left. The obvious male characters include a longer tegmen, perfectly developed male cercus and right hand portion of the subgenital plate. The female side shows a short tegmen, short stout cercus, typical left half of subgenital plate and half of an ovipositor. This specimen, as noted, is in the author's collection.

Idiostatus inyo Rehn and Hebard (Figs. 4, 20, 44, 74-76, 103)

Idiostatus inyo Rehn and Hebard, 1920, p. 254, pl. 10, figs. 6-8.

Type data. — Single label, handwritten. "Near Owens Lake, Inyo County, California, July 1912."

Type locality. — No additional information on the type locality is available. Owens Lake is currently receding due to man's activity and that area may become inhospitable to the katydids. The surrounding mountains likely harbor the species and may actually be the exact area from which the type was collected.

Deposition of holotype. — The holotype is in the Academy of

Natural Sciences of Philadelphia.

Diagnosis. — Size medium for genus, form attenuate to robust. Coloration greyish or brownish, without green; stripe present or absent on outer pagina of hind femur. Male distinctive in following characters: tegmen unicolorous, usually reddish brown; tergite ten (fig. 44) modified, broadly convex dorsad, apex U-shaped to a depth not exceeding one-third the dorsal length, lateral apices broadly acute; cercus (fig. 44) with main shaft elongate, apex broadly acute; inner tooth placed in apical two-thirds of median portion of shaft, short, stout in northern populations, acute in southern portion; titillator (figs. 75, 76) with base well developed, bulbous; arm tubular, varying in length, usually untoothed. Females may be identified by the following combination of characters: tergite ten with broad, deep median incision separating it into halves; cercus elongate, tapered, six times longer than basal width, apex sharply acute, distinctly directed inward; subgenital plate longer than basal width, incised for half its length; ovipositor nearly as long as hind femur, weakly curved upward, with only a few scattered tubercles indicating position of lateral carinae.

I. inyo is a nocturnal inhabitant of the Pinyon-sagebrush community of the eastern flanks of the Sierra Nevada Mountains of California (fig. 20).

Species description. — MALE. Size small (northern portions of range) to medium (central portions of range) to moderately large for genus (southernmost records). Form moderately robust. Fastigium of vertex well produced, twice as broad as width of first antennal segment. Eyes dorso-ventrally elongate, moderately bulging (type locality and vicinity) to flattened (Walker Pass) to prominently bulging (Tom's Place). Eye only slightly longer than broad (northern records) to twice as long as broad (Lone Pine and south). Frons and genae pitted. Antenna as long or slightly longer than body. First antennal segment 1.5-2.0 times longer than broad; second segment one-third as long as first, one-quarter as broad. Third antennal segment slightly longer than second. PRONOTUM smooth dorsally, median carina indicated only by color; anterior margin broadly undulant, straight to slightly concave mesad; posterior margin truncate, to broadly obtuse; anterior margin of lateral lobe broadly undulant, straight to distinctly concave; posterior margin declivent, concave dorsad; ventral margin of lateral lobe obtuse (southern records) to truncate (northern records); posterior one-third of disk with distinct humeral angles, not suggestive of carinae; surface of lateral pronotal lobes feebly rugulose; anterior one-fifth of disk with shallow, undulant transverse sulcus, nearly obsolete dorsad but distinct, deeply indicated on anterior dorsal portion of lateral pronotal lobe. TEGMINA protruding beneath pronotum for a distance of at least three-quarters the dorsal length of pronotum. Left tegmen with left margin straight, right margin produced anteriorad, with a second broadly obtuse lobe mesad, weakly undulant to apex; main veins prominent, central cells large, smooth. Veins of distal portion short, stout, net-like. APPENDAGES. Legs slightly longer than normal for genus. Hind femur surpassing apex of abdomen at least for one-half its length. Fore femur shorter than dorsal length of pronotum. Metatarsus of

hind tibia slightly subequal to distal tarsal segments, not including claw. Plantula of hind tarsus well developed, elongate, narrowed basad, expanding in median portion, narrowed to acute apex. ABDOMEN dorsally with microscopic granulations, densely pilose; dorsal carina indicated only by color; tergite ten modified, dorsally broadly convex dorsad, in length greater than tergite nine but subequal to tergites eight and nine combined; apex of tergite ten with broad U-shaped excavation to a depth not exceeding one-third the dorsal length of tergite ten; median portion of excavation distinctly but not greatly membranous, never approaching that of the *californicus* Group. This renders the anterior portion of excavation concave in appearance. Apices of tergite ten broadly acute (figs. 43, 44), never approaching that of *I. aequalis* (figs. 48-51). Dorsal surface of tergite ten lightly pilose, especially distad. Cercus (figs. 43-44) with inner tooth placed in apical two-thirds (middle and northern portions of range) or in median portion (southern portions of range); inner tooth short, stout, directed inward on same plane as main shaft (middle and northern portion of range) or elongate, spike-like, two-thirds as long as distance from its base to apex of main shaft, distinctly directed upward (southern portions of range). Entire cercus densely clothed with long pile (northern and central portions of range) or only slightly pilose (southern localities). Subgenital plate scoop-shaped, elongate, narrowed apicad; ventral surface subcarinate in region of styles, the broadly rounded ridges extending proximad to median region of plate; middle portion with median proximal ridge; median incision shallow, distinct; styles well developed, elongate, longer than length of one side of medial incision. Titillator (figs. 74-76) with base well developed, as in *aequalis* Group. COLORATION. General coloration "salt and pepper" grey and light brown. The largest percentage of specimens is greyish with brown forms encountered in less than 25% of specimens. All specimens have disk of pronotum and adjacent dorsal portion of abdomen lighter in color than lateral portions of body. Fastigium of vertex and eye either with or without black ring. Eye grey to grey brown. Posterior portion of pronotum, in region of humeral angle, with narrow, indistinct longitudinal black stripe (dark specimens) or small black or brownish spot (lighter specimens) positioned dorsad to white creamish area which extends from humeral angle of lateral lobe ventrad to ventral anterior angle of lateral lobe. Legs mottled with darker body colors. Darker specimens often possess a black longitudinal stripe on outer pagina. All spines black basad, brown or black distad; median two-thirds of spines creamish white. Teeth of femora uniform black with veins and cells unicolorous reddish brown to light straw brown. Outer membranous margin of tegmen white. Cercus concolorous with basic body color, usually speckled; teeth with apices dark brown. Subgenital plate and ventral surface of abdomen usually creamish white, often with grey speckling. All pile of body white. No green present either on nymphs or adults.

Holotype measurements. — From Rehn and Hebard (1920:255). Length: body, 19.50; pronotum, 5.20 × 5.00; fore femur, 5.20; middle femur, 6.00; hind femur, 19.30; hind tibia, 20.00; exposed portion of tegmina, 3.70.

FEMALE. Female similar to male but with following exceptions: size

slightly larger, more robust. Tegmen protruding beyond apex of pronotum for a distance not exceeding one-fifth dorsal length of pronotum. Tergite ten with broad, deep median incision separating it into distinct halves. Cercus elongate, tapered, six times longer than basal width; apex sharply acute, distinctly directed inward. Entire cercus sparsely clothed with long, white pile. Subgenital plate longer than basal width, deeply incised medially for half its length, the sides of the incision rather lip-like as in *aberrans* Group. (This is not readily detected on pinned shriveled specimens but it is quite visible in alcoholic material.) Ovipositor slightly curved upward, with only a few scattered tubercles; lateral carina indistinct, usually indicated by three to four tubercles; dorsal and ventral edges distinctly serrate, the dorsal serrations continuous from anterior one-third of that organ to its apex. Ovipositor concolorous with basic body color, either grey, brown, or speckled grey on whitish background; apex darker, the extreme apex black.

Variation. — *I. inyo* exhibits a great degree of variability consisting of both geographic and individual variation. The species shows a distinct cline with regard to size and color. Specimens from the more northerly locations (Tom's Place, Mono County, California; Bishop, Inyo County, California; fig. 20) are usually small and grey. The Benton Station specimens are all brownish. I think this color cline shows an adaptation to a more xeric habitat which is encountered as one proceeds south along the eastern flanks of the Sierra to the Mojave Desert. The Benton Station locality is very desert-like and without dense juniper, pinyon, mountain mahogany, and deerbrush characteristic of other northern localities inhabited by this species. It is almost entirely vegetated by big sagebrush and *Atriplex*. As one proceeds south to Inyo County along the lower margins of the Sierra, the percentage of greyish individuals drops, with brown ones becoming more commonly encountered. Only two of the seven from Walker Pass are grey. In Mono County, along the Sierra foothills, there are many green or greyish plants and a light granitic soil which would tend to correlate with the predominance of grey color. At Lone Pine, Inyo County, California, where there is a mixture of desert vegetation with the juniper-pinyon woodland, one finds a higher percentage of brown specimens, but with grey still predominating. The Walker Pass, Kern County, California, area is distinctly more xeric than either of the above localities and has only scattered junipers on the higher slopes with Joshua trees predominating in the region where the katydids were taken.

Size also varies geographically. A distinct cline in body size can be seen if one plots the distribution of *I. inyo*. Mono County or northern specimens are only half the size of those from Walker Pass; Independence and Lone Pine material are intermediate in this respect. Reasons for this are unclear but one can speculate a shorter maturing time in the northern localities which leads to smaller specimens.

As noted in the description, the shape of the apex of the cercus and the length and direction of the internal tooth show geographic variability. Northern

specimens possess a spatulate cercus without an apical tooth. A tooth is present in the median portion of the range of the species and is well developed in the south. Similarly the internal tooth of the cercus shows its greatest development in southern specimens. Whether individuals from the northern portion of the range of the species could successfully mate with those from the southern localities is not known but is a critical question in determining the specific distinctness of the populations.

I. inyo shows an uncommon degree of individual variation in the length and armature of the male titillator. A single individual may have one arm short, the other fully twice as long. At one locality, one may encounter a small percentage of individuals with very small teeth on the outer edge of the titillator arm. There is considerably more variation in this character in *I. inyo* than seen in the more widespread *I. aequalis.*

Females show no detectable clinal variation in any characteristics other than size (Table 8) and this is not readily obvious due to the lack of specimens from critical areas. Females show some variability in the length of the ovipositor relative to the length of the hind femur. One might be led to believe that the mesal tubercle of sternite seven is variable, but because it is so small, it is easily distorted in drying and hardly recognizable in pinned specimens. Material preserved in alcohol should be used when studying this character.

EGGS. — Eggs from a female collected near Westgard Pass, Inyo County, California, in 1967 agreed with number 93 (yellow grey) on the ISCC-NBS color chart. Egg measurements, Table 9.

Seasonal occurrence. — Earliest adult records for *I. inyo* are 2 July (four miles west of Big Pine, Inyo County, California) and the latest 21 September (Walker Pass, Kern County, California).

Song. — *I. inyo* is nocturnal and sings with a characteristic low buzz. When disturbed this slows to the short "zics" so common with many other *Idiostatus.*

Distribution. — *I. inyo* occurs (fig. 20) along the eastern base of the Sierra Nevada Mountains from near Mono Lake south to Walker Pass. The easterly limits of the range of the species are as yet uncertain but it is known from the Westgard Pass, Inyo County, California, region. Altitudinally the species has been found in the Big Sagebrush community between 4,000-5,000 feet elevation and from the Pinyon-juniper community from between 5,000-7,000 feet elevation. At Glacier Lodge, 11 miles west of Big Pine, Inyo County, California, *I. inyo* was found in the Jeffrey pine community at over 9,000 feet elevation. At the latter locality the species was ecologically separated from *I. callimerus* which was found within 50 feet of it but in a high chaparral situation among talus and large rocks without trees.

Records. — CALIFORNIA: INYO COUNTY: Big Pine, 4 mi. W., 18 June 1961 (J. S. Buckett, 1 last instar ♀, UCD); 2 July 1961 (D. C. Rentz, 2 ♂♂, 5 ♀♀, ex: *Eriogonum*, DCR). Big Pine, 7 rd. mi. SW. (on Glacier Ldg. rd.), 7,000 ft. elev., 25 August 1957 (T. J. Cohn, 1 ♂, 1 ♀, UM). Bishop, 11 July 1964 (J. D. Birchim, 1 last instar ♂, DCR); 10 mi. W., 8 September 1964 (J. S. Buckett, M. R. Gardner, 1 ♂, 1 ♀, UCD); 11 mi. W. at Glacier Lodge, 3 August 1931 (E. R. Tinkham, 3 ♂♂, 5 ♀♀, 2 last instar ♀♀, ANSP). Independence, 25 July 1965 (D. C. Rentz, J. D. Birchim, 7 ♂♂, 5 ♀♀, 2 last instar ♂♂, DCR); 20-25 August 1965 (J. D. Birchim, D. C. Rentz, 3 ♂♂, 7 ♀♀, DCR). Lone Pine, 9 mi. N., 9 July 1961 (D. C. Rentz, 3 ♀♀, DCR); 6 mi. W., 22 July 1965 (D. C. Rentz, 1 ♂, 1 ♀, DCR); 9 mi. W., 6 July 1961 (D. C. Rentz, 5 ♂♂, 8 ♀♀, 1 last instar ♂, CIS, DCR); 22 July 1964 (D. C. & K. A. Rentz, J. D. Birchim, 2 ♂♂, 4 ♀♀, DCR); 3 July 1965 (J. D. Birchim, 1 last instar ♂, DCR); 21 July 1965 (D. C. Rentz, 2 ♀♀, DCR); 23 July 1965 (D. C. Rentz, 1 ♀, 2 last instar ♂♂, DCR); base of Mt. Whitney, 4, 5 August 1931 (E. R. Tinkham, 1 ♂, 3 ♀♀, ANSP). Pine Crk. Cyn., 1 September 1922 (O. C. Poling, 1 ♂, ANSP). Sage Flat camp. 10 mi. W. Big Pine, 20 July 1964 (D. C. & K. A. Rentz, J. D. Birchim, 2 ♂♂, 3 ♀♀, 1 last instar ♀, DCR). Westgard Pass, 5 mi. W. summit, 28 August 1968 (D. C. Rentz, 1 ♀, DCR). KERN COUNTY: Walker Pass, 7 September 1966, 21 September 1967 (D. C. & K. A. Rentz, R. E. Love, 7 ♂♂, DCR). MONO COUNTY: Benton, 20 July 1964 (D. C. & K. A. Rentz, J. D. Birchim, 3 ♂♂, DCR). Lee Vining, 10 mi. N., 8 August 1961 (D. C. Rentz, 1 ♂, 2 ♀♀, 1 last instar ♂, DCR). Mammoth Lks., 7 July 1922 (O. C. Poling, 1 ♂, ANSP). Paradise Camp, 1 mi. NW., 17 July 1965 (J. D. Birchim, 1 ♂, DCR). Tom's Place, 5,600 ft. elev., 13 August 1957 (J. A. Powell, 1 last instar ♀, CIS); 1 mi. W., 9 August 1961 (D. C. MacNeill, D. C. Rentz, 1 ♂, 1 ♀, 1 last instar ♀, DCR); 10, 13 August 1963 (M. R. Lundgren, C. D. MacNeill, 2 ♂♂, DCR); 10 September 1966 (D. C. Rentz, 2 ♂♂, DCR). Whitmore Tub, 2 September 1950 (no collector, 1 last instar ♀, LACM).

Specimens studied. — 115, including holotype.

Hosts. — *I. inyo* has been found on a wide variety of herbaceous plants and trees. Specimens from ten miles north of Lee Vining, Mono County, California, were collected during the day by trampling a very low bush, likely bitterbrush. At Benton, Inyo County, California, also during the day, all of the specimens were found hiding within the spiny protectiveness of saltbush. At Tom's Place, Mono County, California, *I. inyo* has been taken on bitterbrush, rabbitbrush, *Eriogonum* and low pinyon and juniper. All of these specimens were collected at night. Nearly all of the specimens from four miles west of Big Pine, Inyo County, California, were also found at night on *Eriogonum* sp., probably *fasciculatum*, where they were feeding on

young and mature blossoms. One female had captured a scarab beetle, probably *Diplotaxis* sp., which had been feeding on the same flowers. The beetle, although still alive, was nearly half devoured when I collected the katydid. This demonstrates that the species is not "strictly herbivorous" as Tinkham (1944) described but will take animal matter as the opportunity occurs. All of the specimens from six miles west of Independence were either on *Eriogonum* or high (three to five feet) in bitterbrush.

The largest number of katydids from the Lone Pine, Inyo County, California, region were on *Eriogonum* but some were also on rabbitbrush. At Walker Pass, Kern County, California, I found *I. inyo* on a low-growing, sparse composite of undetermined identity. It was found on the same plant with *I. aequalis.*

It can be seen from the above records that *I. inyo* has no specific host plant but feeds on parts and floral components of a variety of herbaceous woody plants. As the opportunity arises, they also feed on some animal matter.

Discussion. — *I. inyo* is an interesting nocturnal species which occurs sympatrically with several other species of *Idiostatus* as well as with other decticines. In the northern portion of its range, *I. inyo* may be found in the same bush with the diurnal *I. inermis.* At higher elevations (Glacier Lodge, Inyo County, California) it is found in close proximity with both *I. inermis* and *I. callimerus.* In the Independence area south to Lone Pine it is completely sympatric with the related *I. birchimi.* The ecological differences, if any, between these two species have not yet been discovered. They are both nocturnal and have been found on the same plant at the same time. At Walker Pass, Kern County, California, the southern known limit of the species, *I. inyo* meets the nocturnal *I. aequalis* at the northerly known limit of its distribution (fig. 20). There, as with *I. birchimi,* the two species may be in competition, both occurring together and feeding on the same plant. Specimens of *I. inyo* from Walker Pass are the largest known for that species; those of *I. aequalis* are among the smallest for that species. The reason for the absence of *I. aequalis* in eastern California (compare maps, figs. 20, 21) may be due to competition with *I. inyo.*

No details of the courtship behavior of *I. inyo* are yet known. Spermatophores attached to females captured at approximately 10:10

PM daylight saving time indicates that mating occurs in mid-evening. The dorsal projections of tergite ten are not unlike those found in *I. fuscopunctatus* of the *aequalis* Group (figs. 43, 47). The tubular shape of the titillator is also similar to those of several species of the *aequalis* Group and additionally serves to relate the two species groups. The ventral tubercle of the female is similar to that of both species of the *aberrans* Group but is never developed to the degree seen in those species. Its function is still unknown but may be stimulated by the male with the dorsal abdominal projections during mating.

Idiostatus callimerus Rehn and Hebard

(Figs. 13, 20, 45, 46, 78, 104; Plate 10)

Idiostatus callimera Rehn and Hebard, 1920, pp. 255-258, pl. X, figs. 9-12.
Idiostatus callimerus, Hebard, 1934, p. 46.

Type data. — Three labels, all printed. 1. "Lone Pine Canyon Sierra Nevada Mts., Cal (R & H)." 2. "8,400 ft., September 8, 1919 (Hebard)." 3. "Type No. H 550."

Type locality. — Rehn and Hebard (1920:258) mentioned that the type series was taken in the open on steep decomposed granite sand slopes, overgrown with much sage and low thorny bushes. This describes well the slopes along the Whitney mountain trail above what is today called Whitney Portal. The type series was most likely collected in this general vicinity.

Deposition of holotype. — The holotype is in the Academy of Natural Sciences of Philadelphia, no. 550.

Diagnosis. — Size small for genus, form robust. Coloration mixture of greys and browns; outer pagina of hind femur irregularly marked with black and grey; no green present in color pattern. Males distinctive in following characters: tegmen appearing longer than normal; fore femur equal in length or slightly longer than dorsal length of pronotum; tergite ten (figs. 45, 46) without lateral modification, central portion moderately soft, incision short; cercus short, stout, only slightly longer than tergite ten, apex tooth-like, directed inward; median incision of subgenital plate broadly concave; titillator (fig. 78) with base well developed, two-thirds as long as arm, arm dorso-ventrally flattened, not tubular, with irregular number of stout teeth, apex toothed on outer margin, recurved. Females may be identified by the following combination of characters: tergite ten with shallow, broad medial excavation; cercus conical broadest basad, evenly tapering to moderately blunt apex; subgenital plate (fig. 104) incised mesad for nearly its entire length; sternite seven with faint indication of

median tubercle; ovipositor subequal in length to hind femur, distinctly upcurved.

I. callimerus is a nocturnal inhabitant of the chaparral community of the subalpine and Jeffrey pine belts of the Sierra Nevada Mountains of California (fig. 20).

Species description. — MALE. Size small for genus, form robust. HEAD with vertex slightly broader than first antennal segment, well produced dorsad. Third antennal segment longer than second. Eyes moderately large, bulging, distinctly dorso-ventrally elongate. Frons and genae moderately pitted. PRONOTUM smooth dorsad, the disk rounded evenly into the lateral lobes except in the distal portion where the characteristic rounded shoulders are present; lateral lobe distinctly wider than long; anterior margin of disk undulant, concave mesad; posterior margin straight, truncate, slightly bowed upward; anterior margin of lateral lobe straight to slightly undulant, ventral margin straight to broadly obtuse; posterior margin of lateral lobe hardly differentiated from ventral margin, the region of humeral angle being the only distinct posterior portion. Disk of pronotum with distinct, shallow, undulant sulcus on anterior one-fifth, this obsolete in median portion of disk; posterior one-third of disk distinctly depressed mesad. Median carina indicated only on posterior one-third to one-quarter if at all. TEGMINA protruding beneath pronotum for a distance nearly equal to or slightly longer than dorsal length of pronotum, rendering the individual distinctly longer winged than other species. Veins of tegmen prominent, short, stout, mesh-like. Left tegmen with left margin straight, slightly concave anteriorad, right margin produced anteriorly, evenly rounded to distal one-third where it is abruptly concave, thence obtuse to apex (fig. 13). APPENDAGES. Legs appearing somewhat shorter than normal for genus. Apex of abdomen attaining apical two-thirds of hind femur. Fore femur equal in length or slightly longer than length of pronotum. Anterior and posterior paginae of fore and middle tibiae with broad longitudinal sulcus. Plantula short, as broad as long, apex truncate, well developed, one-third length of metatarsus. Proximal tarsal segment as long as next two combined, only slightly longer than second tarsal segment. ABDOMEN with distinct median carina dorsad; dorsal surface with scattered rugae. Tergite nine subequal in length to both tergites ten and eight. Tergite ten without lateral modification, convex dorsad, with moderately soft median portion, not membranous, or developed as in the *californicus* or *elegans* groups. Median incision indistinct, the shape determined by the manner in which the specimen dries, never extending more than one-third the depth of tergite ten itself. Cercus short, stout (figs. 45, 46). Subgenital plate longer than broad, subcarinate in region of styles; style two to three times longer than basal width; medial incision poorly defined, not V-shaped, but broadly concave; outer surface sparsely pilose. Titillator (fig. 78) with base well developed. COLORATION. General coloration greyish brown in life, fading to dark brown in death. Head speckled dark brown, without ring. Pronotum with disk lighter brown dorsad, bounded by black on lateral lobes and adjacent dorsal margins. Anterior one-quarter of pronotal disk with light cream-

colored stripes bordering black of lateral lobes and lighter brown of disk. Posterior portion of lateral lobe with broad white to pale yellow area continuous to ventral margin but not onto anterior ventral margin of lateral lobe. Tegmen pale straw brown, almost white, darkened only anteriorad in region of obtuse projection. Tibia uniformly brown, with black annulus in region of auditory foramen of foreleg and in corresponding region of middle tibia. Femora similarly brown with indistinct black subapical band. Hind femur with black dorsal area in proximal one-fifth, another dark region in dorsal median portion, lighter brown to apex where there is a poorly defined lighter brown apical annulus. Abdomen dark brown laterad, dorsad contrastingly lighter grey, unicolorous with pronotal disk, the width of the grey area equal to that of the disk of the pronotum. Region bordering contrastingly colored area with small quadrate white area on each side of each segment. This renders the surface of the abdomen with brushmarks dorso-laterally. Cercus and subgenital plate light speckled grey brown, cercal teeth darker brown. Pile of body whitish. Spines of legs brown at base and apex, median portion straw brown dorsad, the ventral portion forming a brown stripe unicolorous with base and apex.

Holotype measurements. — From Rehn and Hebard (1920:257). Length: body, 19.50; pronotum, 4.40 × 3.20; exposed tegmen, 4.40; hind femur, 14.70.

FEMALE. Similar to male but with following exceptions: size larger, abdomen more robust. Tegmen protruding beyond apex of pronotum for a little more than one-quarter the dorsal length of pronotum. Tergite ten with shallow, broad, medial excavation, indistinct on poorly dried specimens. Cercus densely pilose, conical, broadest basad, little more than twice as broad as basal width, evenly tapering to apex which is moderately blunt. Subgenital plate (fig. 104). Sternite seven with faint indication of median tubercle. Ovipositor appearing short but nearly as long as hind femur, distinctly and abruptly upcurved; tuberculation confined to dorsal and ventral margins and lateral carinae; dorsal and ventral valves with well defined medial lateral carinae in apical one-fifth to one-sixth, these somewhat serrated. Coloration as described for male except that ovipositor uniform grey, to speckled grey, especially basad. Apex and serrations slightly to considerably darker, though never black.

Variation. — Males vary individually in the distance separating the cercal teeth and to a minor extent in the stoutness of the cercus itself. Males from Sage Flat, west of Big Pine, California, show a reduction in the degree of marking of the hind femur. Females from all localities show considerable individual variation in femoral marking, varying from unicolorous without black marking as described. The ovipositor varies geographically in length; southernmost specimens (type locality) possess a gently upcurved ovipositor, longer in proportion to the length of the body; northernmost specimens (Sage Flat, California, and the single female from Tioga Pass, California) possess an abruptly upcurved ovipositor. Spination of the legs shows more than the normal amount of individual variation usually encountered among species of *Idiostatus*. The spination of the anterior margin of the middle tibia is especially variable, the number ranging from zero to three, the posterior margin ranging from two to

four. A single specimen may show this degree of variation. No geographic variation is detectable in the shape or degree of serration of the male titillator but there is considerable individual variation in the length of the arm, degree of undulance and amount of serration of that structure. As with the leg spination, a single individual may illustrate the full range of variation from one side to the other. A single female from the type locality shows dark black markings laterally and medially on tergites seven to ten similar to that which characterizes the *inermis* Group. No other specimen, male or female, has been noted with this character. The larger females, including the last female discussed, possess longer ovipositors, more tapered cerci and hind femora without any markings. From the small number of specimens before me, a cline in size seems to be indicated, the largest specimens in the southern portion of the range of the species (type locality) and the smallest specimens from the northern localities (Sage Flat, Tioga Pass). This may be more apparent than real as may be discovered when the complete geographic range of the species is well sampled.

Seasonal occurrence. — Earliest adult records for *I. callimerus* are 7 July (teneral female, type locality), latest records 9 September (Sage Flat, both sexes).

Distribution. — *I. callimerus* is known from the Jeffrey pine belt of the eastern slope of the Sierra Nevada Mountains (fig. 20) from Tioga Pass south to the Whitney Portal area. Altitudinally the species occurs at least from between 8,400-10,700 feet elevation (Whitney Pass). No other species of the genus has been collected from as high an elevation as the last noted.

Records. — CALIFORNIA: INYO COUNTY: Glacier Ldg., above Sage Flat Camp, 10-11 mi. W. Big Pine, 9 September 1966 (D. C. & K. A. Rentz, 1 ♂, 3 ♀♀); 28 August 1968 (D. C. Rentz, 2 ♂♂, DCR). Lone Pine Cyn., 8,000-8,371 ft. elev., 8 September 1919 (M. Hebard, J. Rehn, 3 ♂♂, paratypes, ANSP). Upper meadows, Whitney Pass, 10,700 ft. elev., 6 September 1919 (M. Hebard, J. Rehn, 1, 4th instar ♂, ANSP). Above Whitney Portal, 7 July 1961, matured 30 July 1961 (D. C. Rentz, 1 ♂, 2 ♀♀, DCR); 8 September 1966 (D. C. & K. A. Rentz, 3 ♂♂, 3 ♀♀, DCR); 27 August 1968 (D. C. Rentz, 2 ♂♂, 1 ♀, DCR). MONO COUNTY: Tioga Pass, Hwy. 120, 9,000 ft. elev., 30 August 1968, matured 7 September 1968, died 14 October 1968 (D. C. Rentz, 1 ♀, DCR).

Specimens studied. — 24, including holotype.

Hosts. — *I. callimerus* is associated with a rather restricted combination of ecological conditions on the east slopes of the high Sierra Nevada Mountains. At the type locality I trampled mountain whitethorn, *Ceanothus cordulatus,* and found the katydids residing in the spiny, dead portions of the plant. At Glacier Lodge, Inyo County,

California, it was found hiding in *Ceanothus cordulatus,* snowberry, *Symphorocarpos* sp. and big sagebrush, *Artemisia tridentata,* all growing on the margins of an extensive talus slope. At Tioga Pass, the single female was taken by trampling a low growing big sagebrush on a flat mesa adjacent to very steep slopes vegetated largely by a tall spiny *Ceanothus.* The steepness of the slopes prevented any further investigation of this particular habitat.

Discussion. — *I. callimerus* (specific name meaning "beautiful thighs") is the most attractive small species in the genus. The combination of colors and the marking of the hind femora are rather unusual in this generally drab colored group of insects. The overall greyish or brownish coloration and the marbled appearance aid in camouflaging this insect in its grey granite surroundings.

I. callimerus, though not especially rare, seems to be an extremely localized species. The same can be said for the grasshopper *Melanoplus platycercus* Hebard known only from Whitney Portal and found in clearings in the Jeffrey pine forest or near timberline, the same ecological situation as with *I. callimerus. I. callimerus,* apparently nocturnal, is unique in that it occurs at elevations often exceeding 9,000 feet. Other high altitude members of the genus such as *I. fuscus* and *I. inermis* are diurnal. I have not personally collected *I. callimerus* stridulating or courting in its habitat at night but when material is brought to the laboratory for study, the species sings and mates only in the dark. For a katydid to be active at such elevations at night when the temperature frequently drops to the freezing point is most unusual. Even the monotypic *Acrodectes philopagus* found on the crest of the Sierra Nevada is solely diurnal, retreating into cracks and among rocks at the mere passing of a cloud under the sun.

I. callimerus is not closely related to any species of the genus. It shares characters with species of both the *inyo* and *aequalis* groups. Females are almost indistinguishable from those of *I. fuscopunctatus,* though males are vastly different. As further material is gathered and the geographic and altitudinal limits of the species are better understood, it may be discovered that *I. callimerus* is a representative of another group of closely related species. When males from Tioga Pass, California, are collected, this will help to elucidate the problem. This species should also be looked for on the east side of

Sonora Pass, California, where a similar set of ecological conditions prevail.

The *aequalis* Group

Members of the *aequalis* Group (*I. aequalis, I. middlekauffi, I. kathleenae, I. fuscopunctatus*) are moderate to small size, slender insects and when mature are obviously adapted to a thamnophilous habit. They lack the bulky, heavy abdomen and shorter appendages of other species groups such as the *californicus* and *elegans* Groups. The species are grey (*I. aequalis,* arid land populations) wood brown or reddish brown (*I. aequalis,* coastal and mountain populations; *I. fuscopunctatus*) or light straw brown (*I. middlekauffi*). No green individuals, either nymphs or adults have been encountered. All of the known species appear to be associated with the chaparral habitat.

All of the species of the *aequalis* Group are nocturnal in their reproductive activities, although feeding and molting may occur during the daytime. Daylight hours are usually spent deep within the protection of the dense bush habitat. At night the insects venture to the tops of the bushes where they feed on blossoms, foliage or insects. Stridulation also occurs at this time. After feeding and courtship, usually after 10 PM DST, the katydids begin to move about, frequently leaving the bushes to venture on to the ground where they wander from place to place. The reason for this behavior is easily explained for those females seeking oviposition sites, but for non-ovipositing females and males the reasons are unknown. Males do not stridulate when they are on the ground, but they have been found feeding at this time.

All known species in the *aequalis* Group require a vertical substrate for courtship. See Rentz (1972). This is an adaptation to thamnophily but also acts as an effective isolating mechanism (see discussion, *I. aequalis, I. fuscopunctatus*). The dorsal extensions of tergite ten of the male of *I. aequalis* are used to stimulate the female during courtship. This step is absent in the presumably sympatric *I. fuscopunctatus* and other known species of this group.

All species of the *aequalis* Group are characterized in having a black spot on the distal surface of each tegmen of the male. Females often, but not invariably, show traces of the spot. The spot may be moderately developed (*I. aequalis, I. fuscopunctatus*), extremely

well developed (*I. kathleenae*) or barely but always indicated (*I. middlekauffi*). The titillator of the male of all species shows considerable basal development. The arm of the titillator is tubular and may be straight, untoothed (*I. aequalis*) or undulant and toothed (*I. kathleenae, I. middlekauffi*). In *I. fuscopunctatus* the arm of the titillator is vestigial and directed downward.

Idiostatus aequalis (Scudder)

(Figs. 12, 21, 48-51, 79-81, 105, 106; Plates 1, 9)

Cacopteris aequalis Scudder, 1899, p. 92.

Cacopteris nevadensis Scudder, 1899, p. 91. Type locality: Ruby Valley, Elko County, Nevada. Lectotype here designated: male labelled "Palmer's Assorting #1071." Type No. 14152 in the Museum of Comparative Zoology, Harvard University. **New Synonymy.**

Cacopteris femorata Scudder, 1899, p. 93. Type locality: "S. Sta. Monica, Los Angeles County, California." **New Synonymy.**

Idiostatus aequalis, Caudell, 1907, p. 376.

Cacopteris aequalis, Rehn and Hebard, 1920, p. 251.

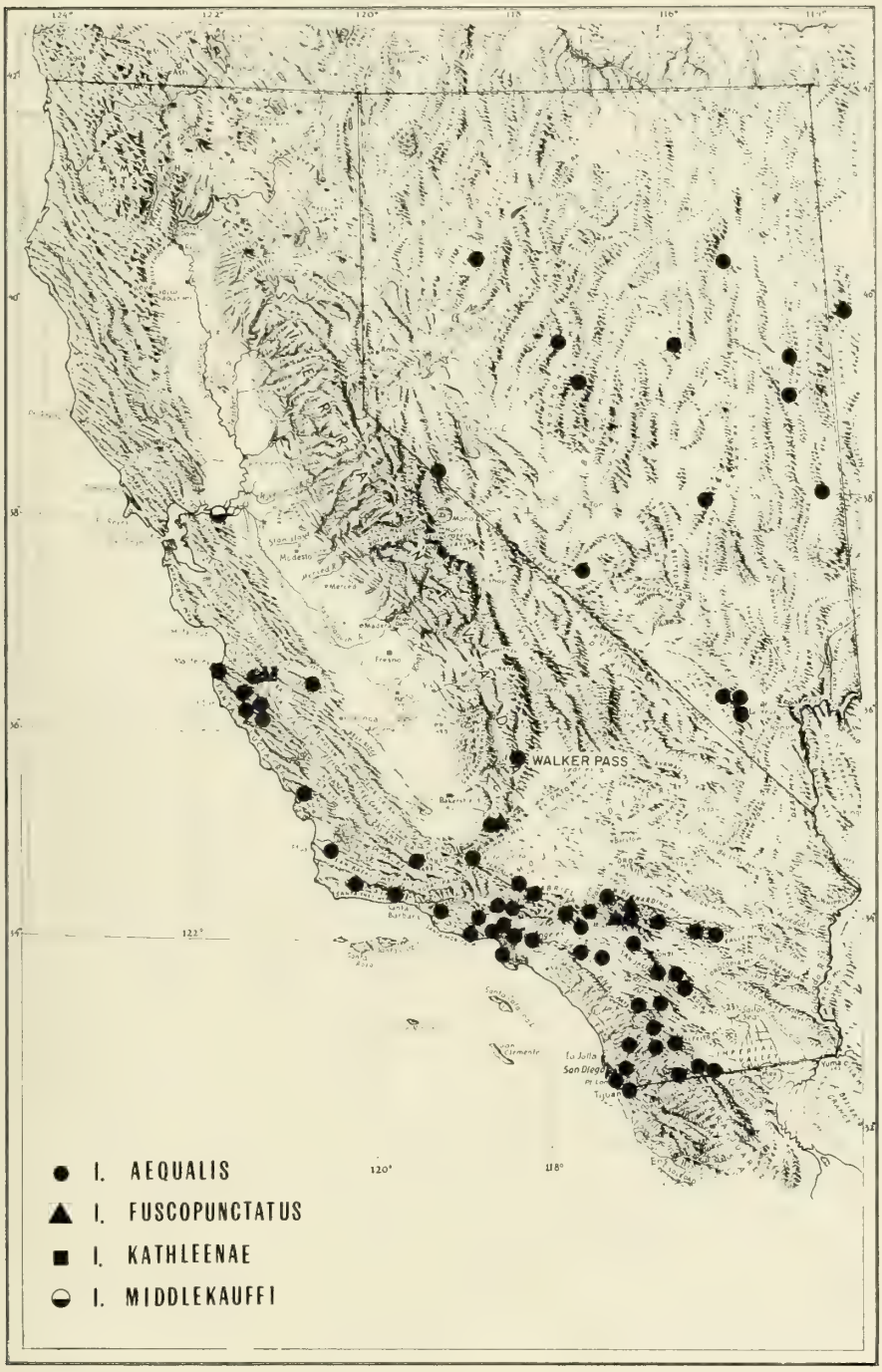
Idiostatus aequalis, Hebard, 1934, p. 45.

Type data. — Described from a series of nine males and five females stated in Scudder's original description as coming from Los Angeles, Cahon [sic] Pass and Mt. Wilson (Altadena), California. Lectotype here designated: male labelled 1. "Cajon Pass, California, July 19, 1897." 2. "Scudder's type #14153."

Deposition of lectotype. — The lectotype is in the Museum of Comparative Zoology, Harvard University, No. 14,153.

Diagnosis. — Size small (desert populations) to large (coastal populations), form moderately attenuate for species group. Coloration reddish brown or greyish, the latter more frequent in specimens collected under xeric conditions. Males distinctive in the following characters: tegminal spot moderately developed, tergite ten dorsally flat with two projections varying in length geographically; cercus with internal tooth modified and greatly elongate (figs. 48-51); titillators with base well developed, arm variously developed, as long or longer than base or knob-like, arm nearly straight, without teeth (figs. 79-81). Females may be distinguished from others in the species group by the large size, the swollen cercus, broad subgenital plate (figs. 105-106), ovipositor slightly shorter than hind femur with extensive dorsal sparse tuberculations extending distad of median of ovipositor. The dorsal valve of the ovipositor is laterally carinate distally to a greater degree than seen in other species. Both sexes lack dorsal

FIG. 21. — Known distribution of the *aequalis* Group.


WALKER PASS
I. AEQUALIS
I. FUSCOPUNCTATUS
I. KATHLEENAE
I. MIDDLEKAUFFI

abdominal pilosity. *I. aequalis* is an inhabitant of chaparral situations (fig. 21).

Description. — Lectotype: Male. Fore tibia armed dorsally with two spines on anterior margin, three to four spines on posterior margin. Middle tibia armed dorsally with three spines on anterior margin, four spines on posterior margin. Cercus with apex feebly turned inward, outer toe distinct. Tergite ten with U-shaped median incision, fingers greatly produced. Titillator with arm but little longer than base. Overall coloration reddish brown. Tegmen lighter brown with prominent apical black spot, the lighter veins showing through the spot.

Species description. — MALE. Size medium (southern California populations) to small for genus (northern California and Nevada populations). Form attenuate (southern California populations) to robust (Kern County). HEAD in lateral outline slant-faced. Fastigium of vertex prominent, well produced dorsad. Greatest width of fastigium three-quarters width of eye. Eye prominently bulging, half again longer dorso-ventrally than wide, inner margin distinctly straight (southern California populations) to more oval, greatly bulging (northern California and Nevada populations). Eye three times longer than width of first antennal segment (southern California populations) to two and one-half to three and one-half times as long (northern California and Nevada populations). First antennal segment three times broader than second, third antennal segment longer than second. PRONOTUM smooth dorsally, without any indication of median carina, transverse sulcus weakly indicated on anterior one-fifth and in median disk; anterior margin weakly undulant, posterior margin truncate to slightly concave; humeral angles distinct in posterior one-quarter; posterior margin of lateral lobe produced, abruptly concave to ventral margin which is obtuse in posterior portion, declivent anteriorad; anterior margin of lateral lobe straight; surface of lateral lobe smooth, slight indication of sinus mesad. TEGMINA prominent, protruding beyond pronotum for a distance of greater than one-half pronotal length. APPENDAGES. Legs of normal length to longer than normal for genus (coastal populations). Posterior femur protruding for one-half its length beyond apex of abdomen. Fore tibia armed dorsally with two spines on anterior margin, three on posterior margin. Plantula of hind tarsus well developed, nearly half as long as metatarsus. ABDOMEN. Abdomen dorsally smooth with slight indication of median carination, this likely an artifact in drying. Entire dorsal surface of abdomen without noticeable pilosity. Tergite ten modified, heavily sclerotized, rigid, without pile, deplanate dorsad. Fingers of tergite ten greatly elongate (figs. 48, 49) (southern populations) to reduced, rather stump-like (figs. 50, 51) (northern populations, Nevada populations). No indication of soft membranous area of tergite ten. Cercus broad in basal one-half, the inner tooth expanded greatly, apex distinctly directed inward. Outer apex of cercus or "toe" little more than a swelling (desert populations) to distinctly acute (northern California populations). Entire cercus clothed with long pile. Subgenital plate scoop-shaped with small, indistinct medial incision less than one-sixth as deep as length of plate; styles short,

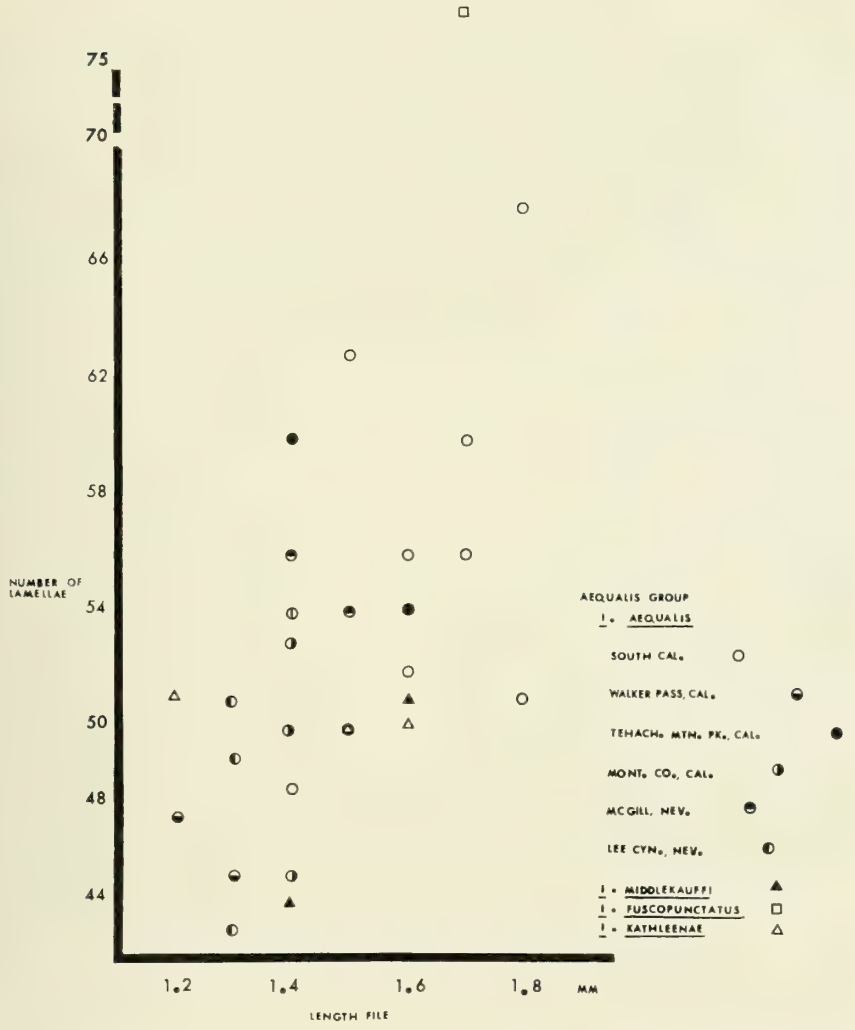


TABLE 6. — Scatter diagram of lamella number plotted against file length for left male stridulatory file.

but longer than length of one side of medial incision. Styles and outer surface of subgenital plate pilose. Titillators (figs. 79-81) with base strong, well developed (northern California populations) to feebly developed (other populations); arm never toothed, tubular, elongate, slightly undulant; apex usually curved inward; arm as long or half again longer than base. COLORATION variable as to habitat. Chaparral and coastal populations usually reddish brown becoming lighter brown to grey in more xeric habitats. Specimens from the type locality vary from light pale brown, with darker brown laterally to dark brownish black. Margin of fastigium and outer margin of eye black, this reduced in

paler specimens. Face "salt and pepper" in darker specimens with two short parallel median stripes, these lacking in light brown specimens. Lateral lobes of pronotum dark, in darker specimens a broad black area present at humeral angle on lateral lobe, this area extending sickle-like over the cream white area of posterior ventral portion of lateral pronotal lobe. White area discontinuous or continuous anteriorly on ventral margin of lateral lobe. Femora darker at joints. Outer pagina of hind femur without any indication of stripe; inner surface with few black spots. Tibia usually darker throughout. Teeth black, spines light brown basally, darker brown at apex. Tarsi unicolorous with basic body color. Dorsal base of metatarsus black laterally. Plantula dark brown to black.

FEMALE. Similar to male but with following exceptions: size slightly larger. Tegmen protruding beyond apex of pronotum for a distance of up to one-quarter the dorsal length of pronotum. Tergite ten with distinct medial sulcation. Cercus elongate, distinctly swollen, apex acute (type locality and California) to blunt, less acute (Nevada, California desert localities). Subgenital plate broad basally, medial incision to one-half its length; lobes slightly obtuse apically (figs. 105, 106), internal apices broadly rounded. Ovipositor shorter than hind femur, straight to slightly upcurved, tuberculate apically, the dorsal tuberculations often emanating at distal one-half of ovipositor; tuberculations often concentrated on dorsal and ventral margins. Dorsal lateral valve carinate at apex. Ovipositor usually unicolorous with basic body color, either light or dark brown or grey; apex infuscate, extreme apex black.

Variation. — Among populations of such a widespread species (fig. 21), there is apt to be considerable variation. Coastal populations are larger in body size, this is likely attributable to climatic factors, the coastal "growing" season probably longer and more favorable for development. Young instars from Running Springs, San Bernardino County, California, were brought to the laboratory and under "favorable" conditions attained a size fully as large as any of the coastal specimens but distinctly larger than any of the specimens collected as adults from near the former locality. Extremely small specimens from Walker Pass, a desert habitat with Joshua trees and junipers, were found with fully twice the size *I. inyo*.

The vertex of the head varies considerably from nearly flat to obtuse or convex in outline. A range between these extremes can be found at a single locality.

The tubular arm of the titillator shows considerable geographic variability. Populations in San Diego County have the arm short, distinctly three-quarters or less as long as the base of the titillator. In Los Angeles, Ventura, Riverside, Santa Barbara counties the tubular portion is extremely short, the specimen from "The Oaks" showing no more than merely a button. As one proceeds north into Monterey and San Benito counties, the base of the titillator is seen to expand in width and the tubular portion of the arm also to expand. Desert populations of San Bernardino County possess a rather short tubular arm while the small specimens from Walker Pass seem to be intermediate in this condition,

the arm of the titillator being as long as the base in one specimen and slightly shorter in the other. The general pattern of Nevada specimens illustrates a longer titillator arm, the Coleville, California, specimen possessing the longest, the arm of which is fully twice as long as the base. The most northerly record, Trout Creek, Utah, has the titillator arm only slightly longer than the base. Nearly a full range in titillator lengths can be seen in the series from Lee Canyon road, Clark County, Nevada, collection of 1967. The length of the arm varies from three-quarters the length of the base in one specimen to one and three-quarters times longer in another.

As already noted in the description, the outer "toe" of the cercus and the hooks of tergite ten are geographically variable. The hooks of tergite ten show their greatest development in specimens from Riverside, San Bernardino and San Diego counties. The least amount of development among the more northerly populations is found in those from Monterey and San Benito counties in California and throughout Nevada. The cercal toe shows more variation in its development at a single locality than the extensions of tergite ten. However, the more northerly populations from coastal California show its most prominent development. A male from the San Jacinto Mountains shows equal development of this character, while another from Idyllwild shows it to a lesser degree. The series of males from Lee Canyon road, 1967, shows almost a complete range in the development of the cercal toe.

The dark spot at the apex of the tegmen of the male varies in size and intensity with basic color pattern, darker specimens with it black and well developed, lighter specimens having it brownish and barely indicated, although it is invariably present. Females almost always show some darkening on the outer apical margin of the tegmen but it may be darker in some lighter specimens than it is in more intensely colored ones.

Chromosome number. — 2N = 29. Five males from San Bernardino County, California, had the following chromosome complement: 2V + 26R + XR = 29.

EGGS. — Eggs from a captive female from near Running Springs, San Bernardino County, California, compared well with number 60 (light grey brown) on the ISCC-NBS color chart. A captive female laid 43 eggs between 4 August and her death on 19 August 1968. Egg measurements, Table 9.

Seasonal occurrence. — Third and fourth instar nymphs were collected near Running Springs, California, 5,800 feet elevation, 18 June 1968 and matured in the laboratory in late July. Adults are known from 24 June (Gorman) to 22 September (12 miles southwest of Jackson Lake).

Distribution. — *I. aequalis* has a broad distribution (fig. 21). In southern and central California and northern Baja California it occurs in coastal shrub and chaparral situations from sea level to

nearly 7,000 feet. It is absent from the Sonoran Desert but occupies the fringes of the Mojave Desert north into eastern California, Nevada and parts of Utah where it inhabits the Juniper-Pinyon woodland community.

Records. — BAJA CALIFORNIA NORTE: Tijuana, 2 mi. S., 21 August 1931 (E. R. Tinkham, 1 ♂, ANSP). CALIFORNIA: KERN COUNTY: Mts. south of Tehachapi, 7 July 1960 (W. R. Icenogle, 1 last instar ♀, SFSC). Onyx, 14 mi. NE., 19 September 1964 (C. W. O'Brien, 1 ♂, DCR). Paradise Vy., Tehachapi Mts., 7 August 1931 (E. R. Tinkham, 2 ♂♂, 4 ♀♀, ANSP). Tehachapi Mtn. Park, 2,500 ft. elev., 25 June 1968, matured 20 July 1968 (D. C. Rentz, J. D. Birchim, 1 ♂, DCR). Walker Pass, 7 September 1966 (D. C. & K. A. Rentz, 2 ♂♂, 1 ♀, DCR). LOS ANGELES COUNTY: no definite locality, 1 August ? (D. W. Coquillett, 2 ♀♀, USNM). Claremont, 29 July 1926 (J. Beamer, 3 ♂♂, 1 ♀, ANSP). El Segundo dunes, 11 July 1934, 6 June 1941 (J. C. Von Bloecker, W. D. Pierce, 2 ♂♂, LACM). Gorman, (LACM). Gorman, 24 June 1956 (W. E. Simonds, 2 ♂♂, CDA). Hwy. 23, 5.5 mi. S. US 101, 27 June 1968, matured 12 June, 23 July 1968 (D. C. Rentz, J. D. Birchim, 1 ♂, 4 ♀♀, DCR). Jackson Lk., 12 mi. SW. (S. of Pearblossom), 22 September 1968 (J. Emmel, O. Shields, 1 ♂, TJC). Jct. Yerba Buena rd. & Hwy. 23, 27 June 1968, matured 5 July 1968 (D. C. Rentz, J. D. Birchim, 1 ♂, 3 ♀♀, DCR). Llano, 1 June 1957 (W. E. Simonds, 1 fourth instar ♀, CDA). Los Angeles, July ?, July 1886 (D. W. Coquillett, L. Bruner, 2 ♂♂, 2 ♀♀, ANSP). Mint Canyon, 31 July 1935 (J. Beamer, 1 ♂, ANSP). Palmdale, 1 August 1935 (J. Beamer, 1 ♀, ANSP). Pasadena, 824 ft. elev., 1 August 1907 (no collector, 1 last instar ♀, ANSP). Pearblossom, 3 July 1957 (W. E. Simonds, 1 ♀, CDA). Roscoe, Tajunga Wash, 825 ft. elev., 23 August 1909 (no collector, 1 ♂, ANSP). Saugus, 23 August 1909 (no collector, 1 ♂, ANSP). Sta. Monica Mts., 31 May 1954 (no collector, 1 third instar ♀, LACM). Tanbark Flat, 7-13 July 1950, 27 June 1956 (W. C. Bentinck, J. C. Hall, H. L. Hansen, P. D. Hurd, E. G. Linsley, A. T. McClay, G. I. Stage, M. J. Stebbins, 1 ♂, 1 ♀, 8 last instar ♀♀, CIS, UCD, DCR). "The Oaks," Mint Cyn., 2 August 1959 (G. H. Nelson, 1 ♂, UM). Topanga Cyn., 5 August 1938 (R. H. Beamer, 1 last in star ♂, ANSP). Universal City, 10 July 1920 (C. H. Hicks, 1 ♂, 1 last instar ♀, ANSP). MONO COUNTY: Walker, 2 mi. S., 6 July 1966 (C. W. O'Brien, 1 last instar ♀, DCR). MONTEREY COUNTY: Arroyo Seco, 6 September 1958 (W. E. Ferguson, 1 ♀, JRH); Upper Camp, 11 July 1964 (D. C. & K. A. Rentz, 1 ♂, 1 ♀, 1 last instar ♀, DCR). Chew's Lookout, Sta. Lucia Mts. (18 air mi. W. Greenfield), 29 July 1957 (T. J. Cohn, 2 ♂♂, 3 ♀♀; 1 ♂, 2 ♀♀ last instars, UM). Del Monte, 9 September 1910 (no collector, 1 ♂, 2 ♀♀, ANSP). Lockwood, 21 July 1935 (R. H. Beamer, 1 ♀, ANSP). Seaside, 20 ft. elev., behind beach dunes, 24 July 1957 (T. J. Cohn, 5 ♂♂, 1 ♀; 1 ♂, 1 ♀ last instars, UM). Tassajara Hot Sprs., 1,550 ft. elev., Sta. Lucia Mts. (19 air mi. WSW. Greenfield), 28 July 1957 (T. J. Cohn, 1 ♂, UM); 5 rd. mi. N., 4,650 ft. elev., 28 July 1957 (T. J. Cohn, 1 ♂, UM). RIVERSIDE COUNTY:

Anza, 24 June 1958 (L. A. Stange, 1 ♂, LACM). Banning, 28 June, 2 July 1952 (J. K. Hestor, S. Miyagawa, 1 ♂, 2 ♀♀, UCD). Cornoa, 3 July 1919 (E. P. Hewlett, 1 ♂, ANSP). Idyllwild, 17 September 1967 (J. Emmel, O. Shields, 1 ♂, TJC). Joshua Tree Nat'l. Mon., Quail guzzler, 22 July 1966 (E. L. Sleeper, 1 ♂, CSLB); Pleasant Valley, at blacklight, 24 June 1965 (E. L. Sleeper, S. L. Jenkins, 1 ♂, CSLB); Pinyon Wells, 20 July 1968 (E. L. Sleeper, 1 ♂, CSLB); Upper Covington Flat, 5 August 1960 (E. L. Sleeper, 1 last instar ♀, CSLB). Palm Cyn., 800-900 ft. elev., 29 September 1910 (no collector, 1 ♂, ANSP). Perris, 12 July 1935 (M. Gyger, 1 ♂, ANSP). San Jacinto Mts., Pinyon Flats, 27 June 1952 (A. T. McClay, 2 last instar ♀♀, UCD); 13 June 1966 (W. W. Middlekauff, D. C. Rentz, 1 last instar ♀, DCR). San Jacinto Mts., 30 July 1938 (R. Beamer, 1 ♂, ANSP); Strawberry Valley, 5,500 ft. elev., 26 August 1909 (no collector, 1 ♂, ANSP); July 17 (F. Grinnell, 1 ♂, ANSP). SAN BENITO COUNTY: New Idria, 1 mi. S., 31 May 1969, molted 4 June, 10 June, 17 June, matured 4 July 1969 (D. C. Rentz, 1 ♂, DCR). Pinnacles Nat'l. Mon. (W. side), 2 July 1956 (P. D. Hurd, 1 ♀, CIS). SAN BERNARDINO COUNTY: Barton Flats, 21 August 1936 (no collector, 1 ♀, CAS). E. Barton Flats, 30 August 1945 (J. & G. Sperry, 1 last instar ♀, UCR). Cactus Flat, 5,900 ft. elev., 31 August 1919 (J. Rehn, M. Hebard, 2 ♂♂, 1 ♀, ANSP). Cajon, 6 August 1960 (D. C. Rentz, 1 ♂, 1 ♀, DCR). Cajon Pass, 3 mi. N., 29 June 1968, matured 7 July 1968 (D. C. Rentz, 3 ♂♂, DCR). Camp Baldy, 7 July 1952 (A. A. Grigarick, 1 last instar ♂, UCD). Camp O-ongo, nr. Running Sprs., 6,300 ft. elev., 7-14 August 1965 (C. L. Hogue, 1 ♂, 1 ♀, LACM). Desert Sprs., 9 July 1959 (G. H. Nelson, 1 ♂, UM). Lk. Arrowhead, 5 September 1958 (P. Paige, 6 ♂♂, UCD). Miller Cyn., 14 September 1953 (A. Menke, 1 ♀, LACM). Nr. Devore, Cajon Cyn., 6,000 ft. elev., 21 August 1951 (J. Rehn, 1 ♂, ANSP). Running Sprs., 2.5 mi. W. on Hwy. 30, 5,800 ft. elev., 28 June 1968, matured 5 July 1968 (D. C. Rentz, 5 ♂♂, 5 ♀♀, DCR). S. Bdno. Mts., Squirrel Inn, 10 August 1915 (O. H. Kennedy, 1 ♀, ANSP). Smart's Ranch, 2 mi. NW. Horsethief Flat on For. rd. 3NO3, 29 June 1968, matured 7 July 1968 (D. C. Rentz, J. D. Birchim, 1 ♂, 1 ♀, DCR). SAN DIEGO COUNTY: Boulevard, 26 July 1938 (R. H. Beamer, 1 ♂, 1 ♀, ANSP). Campo, 10 August 1935 (R. H. Beamer, 1 ♀, ANSP). Cuyamaca, 6 mi. E., 21 June 1965 (R. L. Langston, 1 third instar ♀, CIS). Descanso, 3,400 ft. elev., 13 September 1922 (J. Rehn, M. Hebard, 1 ♂, ANSP). Jacumba, 24 August 1931, 12 August 1935 (R. H. Beamer, E. R. Tinkham, 1 ♂, 1 ♀, ANSP). Laguna Mts., Resort P.O., 14 September 1922 (J. Rehn, M. Hebard, 1 ♂, ANSP). La Mesa, 12 August 1961 (P. Rude, 1 ♂, CIS). Mt. Palomar, 17 July 1963 (J. Powell, 1 last instar ♀, CIS). Nellie, 23 July 1910, 4-15 August 1917 (E. P. Hewlett, 13 ♂♂, 12 ♀♀, 8 last instar ♀♀, ANSP). Palm City, 7 August 1935 (J. Beamer, 4 ♂♂, 1 ♀, ANSP). Pine Valley, 27 July 1938 (R. I. Sailer, 1 ♂, ANSP). Ramona, no date (P. Rude, 1 last instar ♀, UCR). San Diego, 20 July 1933 (C. C. Wilson, 1 ♀, ANSP). Warner Sprs., September 1919 (G. H. Field, 1 ♂, 1 ♀, ANSP); 28 July 1938 (E. I. Sailer, 5 ♂♂, ANSP); 2 mi. S., 4 July 1956 (G. I. Stage, 1 last instar ♀, DCR). SAN LUIS OBISPO COUNTY: Baywood

Park, Morro Bay, 9 June 1953 (G. I. Stage, 1 last instar ♀, CIS). SANTA BARBARA COUNTY: Solomon Cyn., 12 mi. SW. Sta. Maria, 900 ft. elev., 12 August 1937 (J. Rehn, V. S. L. Pate, J. W. Rehn, 2 ♂♂, ANSP). Sta. Barbara, 0-250 ft. elev., 22 August 1909 (M. Hebard, 1 ♂, 2 ♀♀, ANSP). Zaca, 900 ft. elev., 12 August 1937 (J. Rehn, V. S. L. Pate, J. H. Rehn, 1 ♂, ANSP). VENTURA COUNTY: 2-2.5 mi. S. US Hwy. 101, nr. Sherwood Lk., 27 June 1968, 3 August 1969 (D. C. Rentz, J. D. Birchim, D. Weissman, 4 ♂♂, 2 ♀♀, DCR). Oxnard, September 1914 (J. E. Graf 1 ♀, USNM). NW. corner Vent Co., Quatal Cyn., 5,000 ft. elev., 12 September 1966 (R. L. Langston, 1 ♀, CIS). NEVADA: CHURCHILL COUNTY: Carrol Grade, Hwy. 50, 23 July 1961 (J. R. Helfer, 1 ♂, JRH). CLARK COUNTY: Charleston Mts., Kyle Cyn., 6,500 ft. elev., 2 August 1951 (J. Rehn, 1 ♂, ANSP). Charleston Park, 2 rd. mi. W., 8,000 ft. elev., 8 September 1957 (T. J. Cohn, 1 ♀, UM). Lee Cyn., Spring Mts., 6,000-7,000 ft. elev., 18 August 1919 (J. Rehn, M. Hebard, 2 ♂♂, 1 ♀, ANSP). 3-5 mi. SW. Jct. Hwys. 95-52 on 52 (Lee Cyn. rd.), 29 July 1967 (D. C. & K. A. Rentz, 8 ♂♂, 9 ♀♀, DCR). Mountain Sprs. summit, 14 June 1968 (D. Zoller, R. Yamashita, 2 last instar ♂♂, on *Atriplex canescens,* NSDA). DOUGLAS COUNTY: Coleville, 15 mi. N., 9 July 1930 (E. R. Tinkham, 1 ♂, ANSP). Topaz Lk., 17 July 1960 (D. Q. Cavagnaro, 1 ♀, JRH). ESMERALDA COUNTY: Lida, 3 mi. W., 7 July 1966 (C. W. O'Brien, 2 last instar ♂♂, DCR); 5 mi. N., 19 September 1967 (R. E. Love, 1 ♂, DCR). EUREKA COUNTY: Eureka, 8 mi. W., 6 August 1967 (J. Emmel, O. Shields, 1 ♂, TJC). LANDER COUNTY: Kingston Cyn., east entr. Toiyabe Mts., 5 August 1967 (J. Emmel, O. Shields, 2 ♂♂, 2 ♀♀ last instars, TJC). LINCOLN COUNTY: Emigrant Valley, N. end, 6 mi. S. White Blotch Spr., 5,300 ft. elev., 26 July 1924 (J. Rehn, M. Hebard, 3 ♂♂, 1 ♀, ANSP). Pioche, 23 August 1961 (J. R. Helfer, 1 ♀, JRH). NYE COUNTY: Pine Creek, Quinn Canon Mts., 6,500-6,900 ft. elev., 26 August 1924 (J. Rehn, M. Hebard, 1 ♀, ANSP). PERSHING COUNTY: Rye Patch Sta., 4,300 ft. elev., 23 August 1941 (J. Rehn, J. W. Rehn, 1 ♂, ANSP). WHITE PINE COUNTY: East Crk. Camp, 6 mi. NE. McGill, 9 September 1968 (D. C. Rentz, 6 ♂♂, DCR). East base Connor's Pass, Schell Crk. Mts., 6,625 ft. elev., 5 August 1951 (J. Rehn, 6 ♂♂, ANSP). UTAH: JUAB COUNTY: Trout Creek, 29 July 1933 (H. B. Stafford, 1 ♂, 1 last instar ♀, ANSP).

Specimens studied. — 285, including type series.

Hosts. — *I. aequalis* has no specific host plant but is associated with the chaparral community. In southern California (near Sherwood Lake, Yerba Buena road, Running Springs) young instars were found in grass and small herbs on hillsides bordering dense chaparral. At the type locality, adults were found feeding and stridulating at night on the dead buds of *Eriogonum fasciculatum.* During the day the insects could be seen hiding in the dense growth of *Eriogonum.* In Nevada (McGill) males were found singing in the early evening in junipers and mountain mahogany.

I. aequalis is probably omnivorous, feeding mostly on plant material but eating animal matter as opportunity provides. In Nevada (Lee Canyon road, 1967) individuals were commonly found on the highway at night cannibalizing dead and dying individuals. They were also seen feeding on *Chrysothamnus* sp. blossoms which were common on the roadside. Grasses are also fed upon, probably mostly by juveniles early in the year when they are on the ground and green grass is abundant. In the Tehachapi Mountains I found a last instar male sitting atop a partially dried oat stalk, *Avena* sp., chewing on a seed.

Gut contents of nymphs collected near Running Springs, San Bernardino County, California, were examined microscopically and compared with samples of various plants collected at the same habitat. The plant samples were ground into micro-particles with a blender to stimulate what one might find if the same plants were present in the insect gut. Few insect parts were detected. There was a predominance of bracken fern, *Pteridium aquilinum,* consisting of both spores and leaf fragments.

Discussion. — The placing of *I. nevadensis* as a synonym of *I. aequalis* is warranted when a large series of specimens from various localities is studied. The species heretofore was distinguished almost solely on the basis of geographical distribution — if it came from Nevada, then it was called *I. nevadensis.* A few minor differences in the length of the structures of the male on tergite ten and coloration had also been used. But these are variable when the entire geographic range of the species is considered. The cercus of the male is almost uniform throughout the range of the combined species, but there is some variation in the degree of development of the outer tooth or more properly the apex of the main shaft, but a range in this variation can be found among specimens from a single locality. Since this structure is not critical in copulation (the outer tooth never comes in contact with the female) some variation in this part of the structure is not unexpected.

The majority of the specimens on hand from Nevada are pale in coloration, light brown if the basic color is brown or light grey. This latter color phase has been seen in California only among populations occupying a xeric habitat such as at Joshua Tree Monument or San Benito County. Presumably this is an adaptation to the grey

soil and foliage prevalent in that habitat. The lectotype of *I. nevadensis* is grey.

Grey forms have never been encountered at the higher elevations or along the coast of southern California. Curiously, not a single specimen has been found with green in its color pattern, either as nymph or an adult. Near Running Springs, San Bernardino County, California, a series of specimens collected both by myself and others shows no trace of green but representatives of *I. viridis* collected near there are predominantly that color. The presence of green coloration can be used to separate individuals of the two species.

The name *Cacopteris femorata* Scudder had been overlooked since Caudell (1907:387) discussed it briefly. Lacking males and possessing solely the type, he felt that its cerci were similar to *I. inermis* but were unlike other species in the genus because of its longer limbs. The ovipositor (18.5 mm) was considerably shorter than the hind femur (25.0 mm). The body measured 20.5 mm, with the pronotum 5.75 mm in length. If Caudell had had in his possession additional coastal material of *I. aequalis* he would almost certainly have seen the obvious. Scudder had even fewer specimens, less than two dozen, of *I. aequalis, I. femorata,* and *I. nevadensis* when he described them and with his sharp eye it is somewhat surprising he concluded *I. femorata* was distinct species.

I. aequalis is thamnophilous in the adult stage, occupying a wide range of habitats from sea level to nearly 8,000 feet elevation and showing considerable variation in size. Size variation may depend upon the length of time needed to mature, quality of the food supply and possibly even weather conditions. I have examined the type of *Cacopteris femorata* and find it similar in all respects to what I consider *I. aequalis.* Its size is not unusually large when series from many localities are examined (Tables 7, 8). With longer growing season, as is the case along the coast, one might expect to find larger specimens than from xeric or montane habitats.

One might be led to the belief that there is little if any gene exchange between the Nevada populations and those of California, Death Valley and the desert ranges acting as barriers separating the two (fig. 21). However, I feel we do not know enough about the occurrence, or more importantly the lack of occurrence of the insects in certain areas. Unfortunately, no collecting for these katydids

has been done on the northern fringes of the Mojave desert in the Avawatz or Granite Mountains of eastern California.

Similarly the Panamint and Saline Valleys have not been investigated. If intermediates were to be found in this region, then there would be justification in naming the Nevada population as a subspecies. The records from Lee Canyon and the Spring Mountains, both in Nevada, do not show an intermediate condition regarding the length of the projections of tergite ten, the only really measurable character separating the two. In this respect, that population is similar to others in Nevada. The three specimens from Walker Pass, California, are the smallest seen in available series. Occurring sympatrically with it on the same plant was *I. inyo,* a species known from Walker Pass and north along the eastern slope of the Sierra to Tom's Place. *I. inyo* shows clinal variation in size, the smallest specimens at the northern limits, the largest at Walker Pass. Morphologically, the Walker Pass examples of *I. aequalis* have the projections of tergite ten longer than seen in Nevada specimens.

If somewhere between the northern Mojave Desert both forms could be found and the breeding integrity demonstrated, justification for retention of the names would be possible. Perhaps detailed analysis of the calling songs of males from different localities would prove useful.

Although *I. nevadensis* has page precedence, the current Code of Zoological Nomenclature (1964) does not recognize the old page priority rule. In view of the geographically restrictive meaning of the name *I. nevadensis* and the representation of *I. femorata* solely by a female, it seems most useful to regard *I. aequalis* as representative of the species. The type locality of the latter is more restricted than that of *I. nevadensis* which was published differently from that which is stated on the label. As noted under the synonymy of the species in this study, the lectotype of *I. nevadensis* is labeiled simply "Palmer's Assorting #1071." Apparently this was interpreted as Ruby Valley, Nevada, by Scudder and I have no reason to doubt this was the type locality. Collecting in the Ruby Valley in 1968 yielded no specimens, but it was an extremely dry year and it is possible that the katydids were gone in September when the visit was made. To the southeast in the Schell Creek Mountains, *I.*

aequalis was commonly found at night. The situation there seemed much less drought-like and the season less advanced than in the Ruby Mountains.

As with other species in the *aequalis* Group, *I. aequalis* mates only at night. Consequently one encounters stridulating individuals only at that time. The katydids are not completely inactive during the day but hide in dense bushes and can be seen to feed or sun themselves. The major portion of the feeding activity is accomplished at night when the insects expose themselves more freely under lessened predatory activity and ascend to blossoms or otherwise exposed food sources.

Sexually receptive females approach a singing male and the two invariably move to a vertical position for courtship (Rentz 1972). Courtship can occur horizontally but the pair is always unsidedown, as on the underside of a leaf or branch. The species was never seen to court on a horizontal substrate, even when forced or "led" into such a position. Cages in which all branches were removed forced the mating individuals to the sides of the cage where they attempted courtship.

Females crawl atop males as normal for the genus but the male commences stroking the ventral surface of the female's abdomen using the extensions of tergite ten for this behavior. The male continues the abdominal stroking for several seconds using even, long strokes with the apical quarter of his abdomen unusually arched. During the abdominal stroking phase, the female continually palpated the dorsal surface of the male's abdomen. Shortly thereafter copulation was achieved, usually after one or more attempts and a spermatophore was transmitted.

It is interesting to speculate on the possible function of the abdominal stroking portion of the courtship behavior. *I. aequalis* occurs sympatrically with *I. inyo, I. viridis,* and doubtlessly also with *I. hermannii, I. elegans* and *I. kathleenae* (figs. 16, 18, 21). In addition the species also occurs with other decticines in such genera as *Ateloplus, Oreopedes, Neduba,* and *Capnobotes.* With the exception of *I. elegans* and *I. hermannii* all of the species of *Idiostatus* listed above are nocturnal, presumably performing courtship activities at the same time as *I. aequalis.* All of the species in the *aequalis* Group utilize a vertical substrate during courtship as do all other

thamnophilous species. It is also an effective isolating mechanism preventing hybridization by other species (possibly *I. inyo*) which mate in a horizontal position. The fact that the species mates only at night would likewise prevent attempts at crossing between such sympatric species as *I. elegans* and *I. hermannii*.

When males of *I. aequalis* were placed with females of *I. fuscopunctatus* courtship occurred and proceeded normally until the abdominal stroking stage at which time the *I. fuscopunctatus* females jumped away, this strange behavioral step being not at all a part of that species' courtship repertoire. Similarly males of *I. fuscopunctatus* when placed with females of *I. aequalis* were unsuccessful in attempting copulation, ostensibly due to the lack of abdominal stroking. The females wildly jumped away when the cerci were maneuvered into copulatory position without the prior abdominal stroking step.

Idiostatus middlekauffi new species

(Figs. 10, 21, 52, 82, 107, Plate 10)

Type data. — Two labels. 1. "Antioch, C. Costa Co., Cal., 23 June 1961." 2. "D. C. Rentz collector."

Type locality. — The type locality is what remains of the Antioch Sand Dunes approximately one-half mile west of the Antioch Bridge on the south shore of the juncture of the Sacramento-San Joaquin Rivers. The remaining vestiges of the once fairly extensive dunes are beneath the large, conspicuous electric tower adjacent to the "Little Corral Bar" on Wilbur road.

Deposition of primary types. — The holotype and allotype are deposited in the California Academy of Sciences, No. 10,493.

Diagnosis. — Size moderately large for species group, form elongate. Males are distinguished from those of the closely related *I. kathleenae* by the proportionately longer main shaft of the cercus (fig. 52) and the shape of the titillators (fig. 82). Females possess a straight ovipositor which is elongate, slightly longer than the hind femur and without lateral carination. Characters common to both sexes are: development of the fastigium, well indicated lateral extremities of the transverse pronotal sulcus, reduction of the intensity and size of the tegminal spot (males), and overall high percentage of pale-colored individuals.

Description. — HOLOTYPE MALE. Size moderate for genus, form attenuate. Fastigium well produced, more so than in any other species in the genus; apex smooth, well rounded. Eyes moderately bulging, dorso-ventrally elongate,

slightly directed anteriorly. Eye two and one-half times longer than first antennal segment. Frons and genae moderately pitted. First antennal segment two and one-quarter times broader than second. Third antennal segment longer than first. Antennae slightly exceeding length of body. PRONOTUM deplanate dorsally, median carina indicated only by color; anterior margin slightly concave mesad; posterior margin of pronotum truncate to slightly obtuse; posterior margin of lateral lobe almost uniplanar, straight, with little curvature, ventral margin of lateral lobe broadly obtuse; posterior one-third of disk with humeral angles distinct but not well indicated; anterior one-fifth of disk with transverse sulcus, broadly bowed posteriorly to median of disk where it is all but obliterated; lateral extremities of transverse sulcus deeply indicated. TEGMINA protruding beyond apex of pronotum for a distance of one-half to three-quarters its dorsal length. APPENDAGES. Anterior femur slightly longer than dorsal length of pronotum. Hind femur protruding beyond apex of abdomen for a distance of half the length of femur. Fore tibia with two spines on anterior dorsal margin, three on posterior margin. Plantula of hind tarsus well developed, bilobed, one-fifth to one-quarter length of metatarsus. ABDOMEN with slight indication of median carina, as modest dorsal extension of posterior margins of abdominal tergites. Tergite ten not greatly modified. Median portion with shallow to broad sulcus, one-half to three-quarters length of tergite; this may be an artifact of drying since some specimens do not possess it. Tergite ten without any indication of soft medial area. Cercus with main shaft elongate. Titillator (fig. 52). Subgenital plate elongate, narrowed apically, median incision less than one-fifth the length of plate itself; styles varying from slightly longer than to only half as long as length of one side of median incision. COLORATION. General overall coloration pale straw brown. Tegmen uniformly light straw brown. Tegminal spot only faintly indicated. Apices of spines and teeth black. Eyes dark brown. Dorsum of posterior of distal tarsal segment of all legs black. Outer pagina of hind femur unicolorous with general body color. No indication of stripe on outer pagina of hind femur.

Holotype measurements. — Length: body, 22.00; pronotum, 5.00 × 3.20. Tegminal protrusion beyond pronotal apex, 3.80; fore femur, 5.30; fore tibia, 6.00; middle femur, 6.10; middle tibia, 6.90; hind femur, 20.70; hind tibia, 20.30.

ALLOTYPE FEMALE. Similar to male but with following exceptions: size slightly larger. Tegmen protruding beyond apex of pronotum for a distance of no greater than one-quarter the dorsal length of pronotum. Tergite ten with broad sulcus, narrowing anteriorly. Cercus conical, three times longer than basal width, broader in basal half, gradually narrowing to apex; apex acute, straight or slightly directed outward. Subgenital plate about as broad as long, incised mesad for a distance of one-half its length. Ovipositor very elongate, straight, longer than posterior femur; tuberculation reduced, present only on dorsal and ventral margins in apical one-tenth. Coloration as described for male with following exceptions: tegmen uniform straw brown, apical external margin with or without elongate black stripe. Ovipositor dark brown, extreme apex dark brown to black.

Allotype measurements. — Length: body, 23.00; pronotum, 5.40 × 3.10; fore femur, 5.90; tibia, 6.80; middle femur, 6.90; tibia, 7.90; hind femur, 23.00; tibia, 22.70; ovipositor, 25.00.

Variation. — Specimens show obvious variation in the intensity of the color pattern. The most commonly seen color phase is uniform straw brown (23 specimens); the remainder (22) are various degrees of brown with dorso-lateral portions of the abdomen darker grey brown. A single male is dark grey. The tegminal spot of the male is poorly developed in this species, the above grey specimen showing this character most intensely illustrated. Other specimens vary from only a trace of a spot to that situation described for the grey specimen. No single specimen approaches the condition seen in *I. kathleenae* in the development of the black spot. As with *I. kathleenae,* the titillators show considerable variation in the degree of undulation and number and placement of teeth on the titillators.

Derivation of name. — I take pleasure in naming this species for my major professor whose interest in grasshoppers and insect biology has been an inspiration during my years as a graduate student. Naming this insect in his honor is a small token of appreciation of his interests in my behalf.

Seasonal occurrence. — *I. middlekauffi* appears to be found only during early to mid summer since trips to the type locality in August 1962 and 1965 yielded only a few specimens which were missing appendages, an indication that the population had peaked at an earlier date. Adults are known from 23 June to 3 August.

Song. — The call of this species is much like that of others in the *aequalis* Group. It is heard only at night and may be described as a low buzz audible for only 10-15 feet.

Records. — CALIFORNIA: CONTRA COSTA COUNTY: Antioch, 20 April 1937 (E. S. Ross, 1 ♀, CAS); 29 June 1953, 3 July 1953 (G. A. Marsh, R. O. Schuster, 28 ♂♂, 7 ♀♀, CIS); 22 August 1960, 23 June 1961, 17 July 1962, 3 August 1965 (D. C. Rentz, holotype, allotype, 8 ♂♂, 1 ♀, CAS, DCR).

Specimens studied. — 45, holotype, allotype, paratypes.

Hosts. — *I. middlekauffi* was not found to be associated with any particular species of plant but it does prefer a bush habitat. Not a single individual was found in grass situations but rather along the periphery of the large field and along the roadside where bush lupine and shrubbery may be found.

Discussion. — *I. middlekauffi* is unquestionably a member of the *aequalis* Group. Its coloration, tegminal spot and the spination of the fore tibia readily illustrate this relationship. The closest relative

of this species is the much smaller *I. kathleenae* which is known from a similarly restricted locality to the south (fig. 21). It differs from that species in the details of the terminalia, intensity of the tegminal spot and its larger size. The limbs of *I. kathleenae* appear to be proportionately longer relative to body length than are those of *I. middlekauffi.*

The type locality is popularly known as the Antioch Sand Dunes which are aeolian deposits situated on the south shore of the confluence of the Sacramento-San Joaquin Rivers near Antioch, California. Once more extensive (they formerly included several miles of shoreline which is now occupied primarily by industrial developments, the dunes are believed by Carpenter and Cosby (1939) to be late Pleistocene in age. Wind action has deposited the river transported materials on the south banks of the river. The climate is rather typically Mediterranean; dry summers, rainy winters but with frequent "valley fogs" during the winter and early spring. Rainfall seldom exceeds ten inches.

The dunes have now been reduced by sand removal, agriculture and most importantly, heavy industry. All that remains are a few isolated sites along Wilbur Avenue. The katydids were found only at the most easterly site, the type locality. This area is being industrialized and under almost continual disturbance due to sand removal. Vestiges of native vegetation such as oaks, lupines and *Eriogonum* species remain in the small patches of land between the factories but these are for the most part unsuitable for many native insects such as *I. middlekauffi.* One such area, bordering a cement plant, resembles a winter scene at any time of the year. Leaves of all plants within 100 feet or more are coated with a thick, white dust. Little, if any, oak regeneration is occurring within this polluted "zone."

The unique Antioch dunes have long been visited by biologists. The desert-like conditions harbor many representatives of otherwise

FIGS. 22-33. — Terminalia of male *Idiostatus* species. 22. *I. wymorei,* topotype. 23. *I. californicus,* topotype. 24. *I. fuscus,* Grass Lake, Calif. 25. *I. variegatus,* nr. Arco, Ida. 26. *I. hermannii,* Golconda, Nev. 27. *I. hermannii,* 33 mi. N. Jct. Hwys. 95-8A, Nev. 28. *I. hermannii,* W. of Austin, Nev. 29. *I. inermoides,* paratopotype. 30. *I. rehni,* Yreka, Calif. 31. *I. rehni,* nr. Jct. Hwys. 97-A12, Calif. 32. Hybrid, *I. inermis* X *I. rehni,* Jct. Hwys. 97-A12, Calif. 33. *I. inermis,* Hat Creek, Calif.

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xeric habitats. Many studies involving insect taxonomy, behavior and biology have been conducted there mostly by University of California personnel. The most recent investigation was a study of the behavioral activities of a bee *Lasioglossum aberrans* (Crawford) by W. J. Turner (1966). Much of the above descriptive material has been drawn from this work.

Turner listed the following as the most conspicuous native plants found in 1965-66 at the type locality: *Lupinus chamissonis, Heterotheca grandiflora, Senecio douglasii* and *Oenothera deltoides* var. *Howelli.* In addition, he found other plants in isolated stands, and these seem to be the ones preferred by *I. middlekauffi: Lotus Purshianus, L. scoparius, Erysimum capitatum* var. *angustatum, Eriogonum latifolium, Croton californicus, Grindelia humilis, Gutierrezia californica* and *Hemizonia kelloggii.*

Specimens collected by the author were found mostly on bushes but not necessarily species native to the dunes. Two individuals were found on the green leaves of *Datura meteloides* DC which is not native but provides adequate protective cover for the insects. No feeding was noted on this plant. No katydids were found during the daylight hours but it is assumed that the thamnophilous habit provides safety at this time. The proportionately long ovipositor of *I. middlekauffi* seems obviously adapted to the sand habitat. Since the species does not burrow nor lay its eggs in plant tissue (see discussion of *I. aberrans*) the longer ovipositor would place the eggs at a safer depth in the sandy soil where they would be more apt to avoid dessication and would be less likely to wash away during the winter.

Three female katydids which may represent *I. middlekauffi* were found on Mt. Diablo which is not far from the Antioch Sand Dunes

FIGS. 34-47. — Terminalia of male *Idiostatus* species. 34. *I. major,* topotype. 35. *I. magnificus,* nr. Smoky Cyn., Nev. 36. *I. magnificus,* holotype. 37. *I. elegans,* topotype. 38. *I. bechteli,* paratopotype. 39. *I. martinellii,* paratopotype. 40. *I. aberrans,* holotype. 41. *I. apollo,* topotype. 42. *I. birchimi,* 6 mi. W. Independence, Calif. 43. *I. inyo,* 6 mi. W. Independence. 44. *I. inyo,* Walker Pass. 45. *I. callimerus,* paratopotype. 46. *I. callimerus,* Sage Flat Camp, Calif. 47. *I. fuscopunctatus,* nr. Onyx summit, Calif.

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(fig. 21). The three specimens were collected on 14 August 1965 at night. Two were found on the road above Juniper Camp, 2,900 feet elevation; the other was at the summit, near the parking lot, 3,849 feet elevation. A male was heard in a juniper near the summit below the lookout tower but was not seen. Through the courtesy of the California State Department of Parks and Recreation, I have been able to collect and observe Orthoptera in Mt. Diablo State Park for several years. Unfortunately, no males of the *Idiostatus* species were ever collected during this time. It would have been highly desirable to name the park as the type locality of the species because of its permanence contrasted to the ephemeral state of the dunes. To christen a female as the holotype would create confusion in identification since the three Mt. Diablo females differ in some respects from those of Antioch and may actually represent a different species.

The Mt. Diablo examples are more robust and have proportionately shorter ovipositors than those from Antioch. The coloration is similar, two are uniform light straw brown, the other dark grey. In addition, leg spination is typical of the species group and the shape of the cercus and subgenital plate is very much like that of *I. middlekauffi*. The carination and tuberculation of the ovipositor is reduced as in females from Antioch. Only additional collecting will reveal if the two populations represent the same species. If this is the case, the species has a rather broad ecological tolerance since the two areas are very different regarding climate and vegetation.

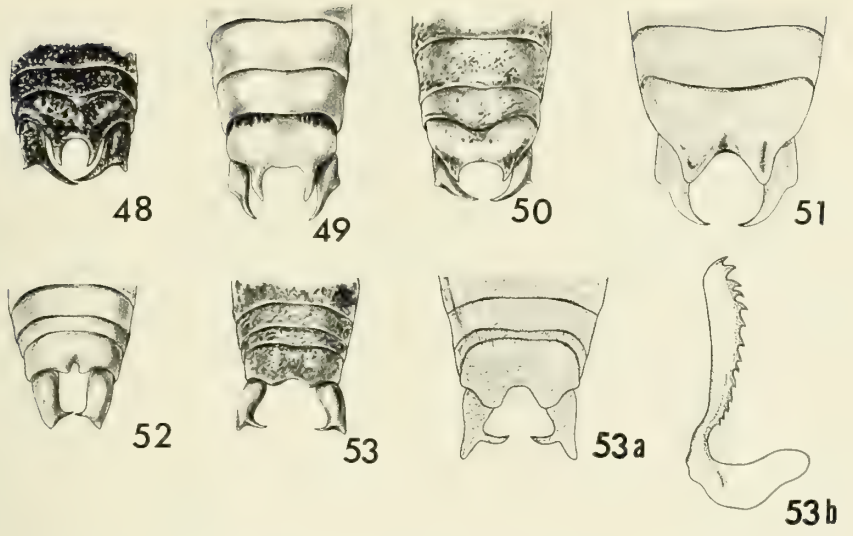
Idiostatus kathleenae new species

(Figs. 11, 21, 53, 84, 108; Plates 1, 9)

Type data. — Two labels. 1. "Calif., San Benito Co., Pinnacles Nat'l Mon., Chalone Camp, 8 July 1967." 2. "D. C. & K. A. Rentz, collectors."

Type locality. — The exact type locality is in the bottom of broad arroyo located in the center of Chalone Camp. The stream is usually dry by mid July and it is vegetated largely by *Baccharis* sp. and *Eriogonum fasciculatum* with chamise, *Adenostoma fasciculatum,* abundant on the periphery.

Deposition of primary types. — The holotype and allotype are



FIGS. 48-53. — Terminalia of male *Idiostatus* species. 48. *I. aequalis,* topotype. 49. *I. aequalis,* Cactus Flat, Calif. 50. *I. aequalis,* Tassajara Hot Sprs., Calif. 51. *I. aequalis,* N. end Emigrant Vy., Nev. 52. *I. middlekauffi,* paratopotype. 53. *I. kathleenae,* paratopotype. 53a. *I. gurneyi,* paratopotype. 53b. titillator, *I. californicus,* Upper McCloud River, Shasta Co., California.

deposited in the California Academy of Sciences, No. 10,494.

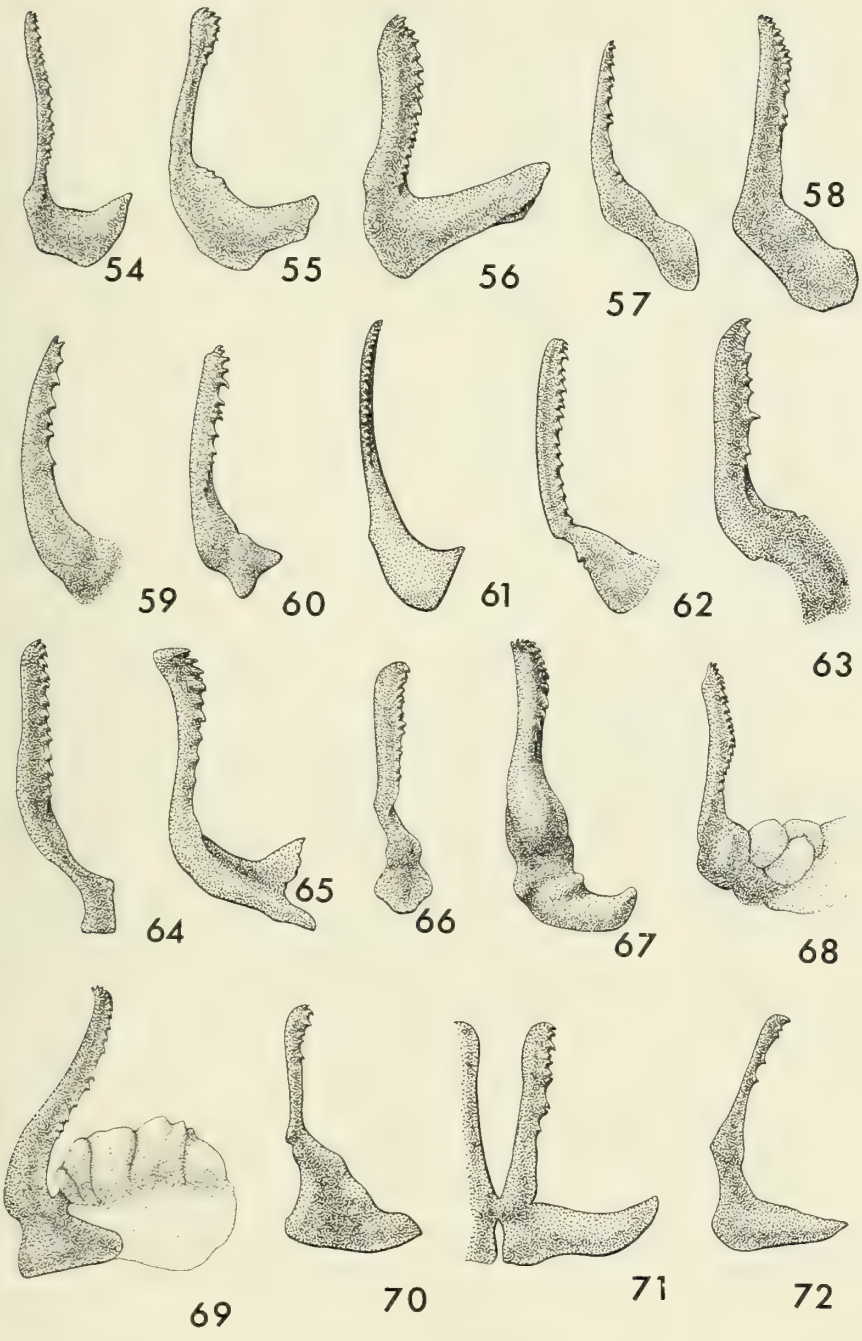
Diagnosis. — Size small, form moderately attenuate for species group. Males distinctive in the following characters: tegminal spot more intensely developed than in any other species, quadrate in outline; tegmina longer than in other species in this group; tergite ten unmodified; cercus dorso-ventrally flattened similar to *I. middlekauffi* (figs. 52, 53) but less elongate; titillator with well developed base, arm elongate, tubular, apex usually recurved, teeth of titillator placed on apical two-thirds of outer margin. Females have a relatively shorter ovipositor than those of *I. middlekauffi.* Lateral carination of apex of dorsal valve of ovipositor highly developed; tuberculations of ovipositor relatively greater in number. Both sexes have relatively elongate legs, little, if any, abdominal pilosity, and usually overall grey coloration. *I. kathleenae* is known only from the type locality where it is found on herbaceous chaparral vegetation.

Description. — HOLOTYPE. MALE. Size small for genus, form attenuate. HEAD rather small, not well seated in the pronotum. Fastigium of vertex well produced, slightly less than twice as broad as interocular distance. Eyes moderately bulging, noticeably elongate dorso-ventrally. Eye two and one-quarter times longer than first antennal segment. Frons and genae slightly pitted. First antennal segment twice as long as second, three times broader. Third antennal segment as long as first. Antennae slightly surpassing posterior femur. PRONOTUM deplanate dorsad, without median carina; anterior margin slightly concave medially, posterior margin of pronotum truncate, somewhat bowed

dorsally; posterior margin of lateral lobe only slightly declivent, ventral margin very broadly convex; posterior one-third of disk with humeral angles broadly bent, not suggestive of carinae; anterior one-fifth with an extensive shallow, broadly undulant sulcus continuous from base of lobe dorsad and across disk. TEGMINA protruding beyond apex of pronotum for a distance of more than half the dorsal length of pronotum. Left tegmen (fig. 11). APPENDAGES. Legs slightly longer proportionately to body length than in other species. Fore femur slightly longer than dorsal length of pronotum, hind femur protruding beyond apex of abdomen for a distance of at least half the length of the femur. Fore tibia armed dorsally with two spines on anterior margin, three on posterior margin. Plantula of hind tarsus rather well developed, bilobed, approximately one-quarter as long as metatarsus. ABDOMEN without any indication of dorsal carina; surface glabrous, not pilose. Dorsum of tergite ten without indication of membranous medial region, no area of pilosity. Cercus (fig. 53) with main shaft narrow. Titillator (fig. 84) with base broad, well developed, elongate with only slightly but distinct medial incision; styles short, knob-like, only three-quarters the length of one side of median incision. COLORATION. The general coloration is dark grey in 17 specimens, including holotype. In addition two are uniform light straw brown and two other specimens are greyish brown with dark red orange legs. The ocular and fastigial margins are black as is the posterior portion of the lateral lobe of the pronotum. The region ventrad to the black humeral mark on pronotal lobe white, extending in some specimens to ventral margin of lateral lobe. Some of the darker colored specimens possess two black, parallel stripes on the face as described for *I. fuscopunctatus.* Eyes grey brown, variegated. Tegmen overall light straw brown, cells and veins in anterior portion of tegmen, in region of acute protrusion smoky black; apical spot well indicated (fig. 11), quadrate in outline, more extensive than seen in other species of the *aequalis* Group. All spines on legs black, at least at base. Femora and tibiae unicolorous with rest of body, no indication of paginal stripe. Dorsum of base of distal tarsal segment of each leg black. Plantula dark brown to black.

Holotype measurements. — Length: body, 19.00; pronotum, 4.40 × 3.20; tegmen protrudes beyond pronotal apex, 3.40; fore tibia, 5.50; fore femur, 4.50; middle tibia, 6.10; middle femur, 5.30; hind tibia, 17.00; hind femur, 17.60.

FIGS. 54-72. — Titillators of male *Idiostatus* species. 54. *I. gurneyi,* paratopotype. 55. *I. wymorei,* topotype. 56. *I. wymorei,* Echo Lk., Calif. 57. *I. fuscus,* nr. Sonora Pk., Calif. 58. *I. variegatus,* nr. Bellevue, Ida. 59. *I. hermannii,* paratopotype, *I. hendersoni.* 60. *I. hermannii,* nr. Rocky Cyn., Nev. 61. *I. hermannii,* W. Austin, Nev. 62. *I. inermoides,* paratopotype. 63. *I. rehni,* 10 mi. N. Weed. 64. *I. inermis,* 15 mi. W. Steamboat, Nev. 65. *I. inermis,* nr. Bartle, Calif. 66. *I. major,* topotype. 67. *I. magnificus,* holotype. 68. *I. elegans,* nr. Rocky Cyn., Nev. 69. *I. bechteli,* paratopotype. 70. *I. aberrans,* holotype. 71. *I. apollo,* east of Cedarville, Calif. 72. *I. birchimi,* topotype.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ALLOTYPE. FEMALE. Similar to male but with following exceptions: size slightly larger. Tegmen protruding beyond apex of pronotum for a distance of no greater than one-quarter the dorsal length of pronotum. Tergite ten with narrow, elongate incision for nearly its entire length. Cercus conical, straight, three and one-half to four times longer than basal width. Cercus swollen basad, abruptly narrowed in apical three- quarters. Subgenital plate rather broad basally, varying from deeply incised to one-half the length of the plate (allotype) to only one-quarter that distance. Ovipositor nearly straight, but distinctly upturned, with small number of distinct tuberculations on dorsal and ventral margins of apical one-sixth. Coloration as described for male. Tegmen with veins light straw brown with black stripe on lower lateral border in some specimens; other have the cells smoky black with a black spot on inner apical margin (allotype).

Allotype measurements. — Length: body, 22.00; pronotum, 4.50 × 3.00; fore femur, 5.20; tibia, 6.40; middle femur, 6.00; tibia, 7.10; hind femur, 20.20; tibia, 20.90; ovipositor, 19.00; exposed tegmen, 1.90.

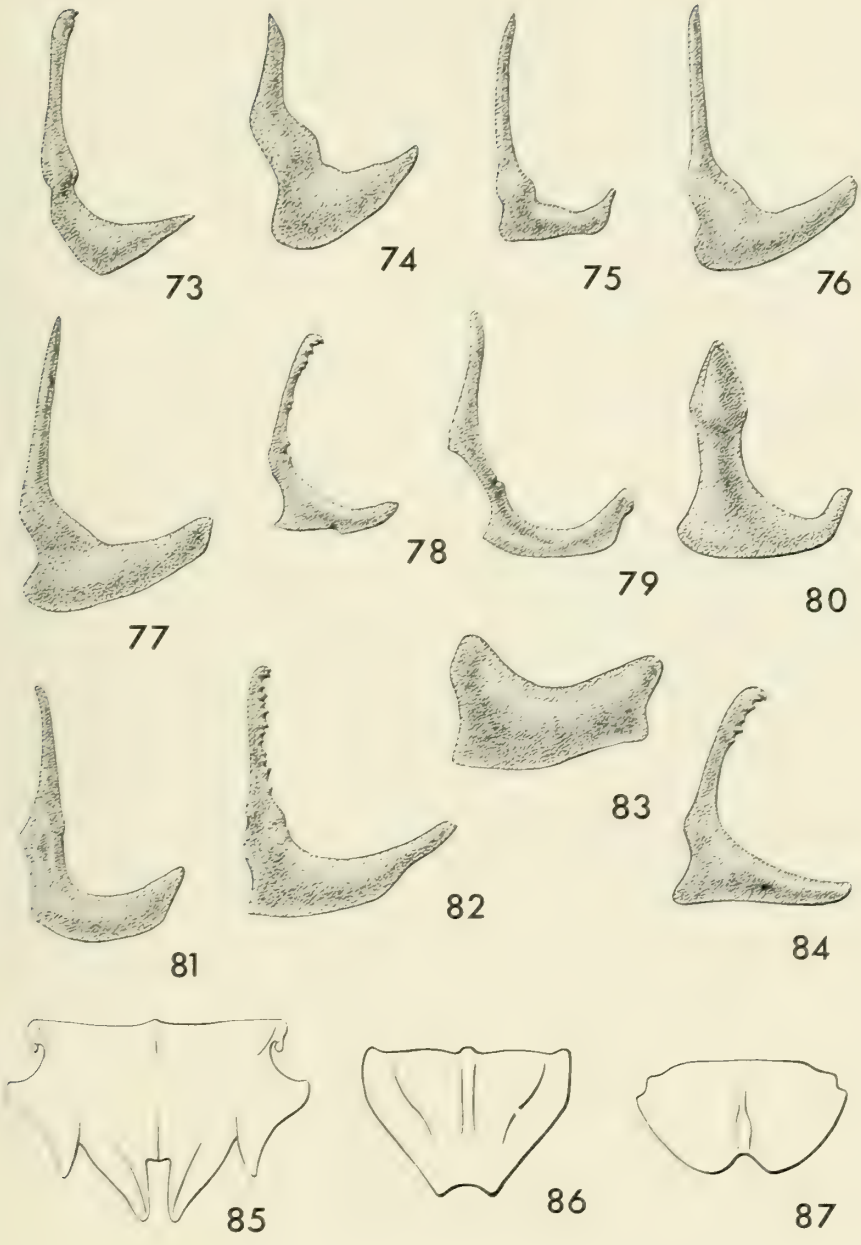
Variation. — Although known from only a single locality, there is notable variation in addition to that of coloration. The series collected in 1966 averages smaller (Tables 7, 8) than those of other years. Rather dry conditions prevailed that year with subnormal rainfall the previous winter. A diminished food supply and shorter growing period may have resulted in the smaller size. The degree of acuteness of the apex of the male cercus varies considerably individually. There is also considerable variation in the degree of serration of the arm of the titillator. Two of ten examples used in this study possess titillators with teeth indicated only as short, blunt tubercles. Other specimens illustrate the condition depicted in fig. 89. No specimen was found with teeth along the entire margin of the arm. There is also some variation in the shape of the titillator itself. Most individuals have the titillator arms parallel for most of their length with the apices divergent. However, others may have one arm or both considerably undulant.

Derivation of name. — This species is named for Kathleen Rentz who has aided in collecting the type series at one of her favorite natural areas.

Seasonal occurrence. — *I. kathleenae* has been collected as adults between 8 July (1967) and 24 August (1962). Nymphs were col-

FIGS. 73-84. — Titillators of male *Idiostatus* species. 73. *I. birchimi,* paratype. 74. *I. inyo,* nr. Bishop, Calif. 75. *I. inyo,* 6 mi. W. Independence. 76. *I. inyo,* 9 mi. W. Lone Pine. 77. *I. inyo,* Walker Pass, Calif. 78. *I. callimerus,* topotype. 79. *I. aequalis,* nr. Running Sprs., Calif. 80. *I. aequalis,* "The Oaks," Los Angeles Co., Calif. 81. *I. aequalis,* Lee Cyn., Nev. 82. *I. middlekauffi,* paratopotype. 83. *I. fuscopunctatus,* nr. Onyx summit, Calif. 84. *I. kathleenae,* paratopotype.

FIGS. 85-87. — Subgenital plates of females. 85. *Steiroxys* sp., Spout Sprs., Ore. 86. *I. gurneyi,* paratopotype. 87. *I. wymorei,* topotype.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lected with adults on the earlier occasion. No specimens have ever been taken at the type locality after late August even though we have returned there in September and October during several consecutive seasons in the mid and late 1960's.

Song. — *I. kathleenae* is a nocturnal species singing shortly after sunset with a continuous low buzz. Individuals have been heard singing until midnight. During a full moon stridulation does not occur but katydids are active and may be found feeding or wandering about on plants or on the ground.

Records. — CALIFORNIA: SAN BENITO COUNTY: Pinnacles Nat'l Mon., Chalone Camp, 24 August 1962 (D. C. Rentz, E. W. Kirschbaum, 1 ♂, 1 ♀, DCR); 30 July 1966 (D. C. & K. A. Rentz, 8 ♂♂, 3 ♀♀, DCR); 8 July 1967 (D. C. & K. A. Rentz, C. & J. Cushner, holotype, allotype, 12 ♂♂, 1 ♀, 3 last instar ♂♂, DCR).

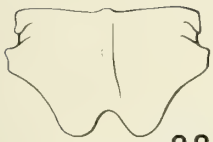
Specimens studied. — 31, holotype, allotype, paratypes.

Hosts. — *I. kathleenae* has been most frequently encountered at night feeding on the blossoms of *Eriogonum fasciculatum* which occurs in creek beds and arroyo situations at the type locality. During the day the katydids take refuge in the dense foliage at the base of these plants. The species is not restricted to this plant and has been taken high in chamise, *Adenostoma fasciculatum,* which grows on the slopes surrounding the type locality.

Discussion. — *Idiostatus kathleenae* is among the smallest of the species in the genus. It is of special interest because of its geographic location which is in the proximity of the very widespread *I. aequalis* (fig. 21). Intensive collecting has been done to determine if the two occur together. At no time was this found to be the case. In addition I attempted to search for the species to the south in the Serpentine Barrens region near New Idria. Only *I. aequalis* was found there.

The two species of *Idiostatus, I. kathleenae* and *I. middlekauffi,*

FIGS. 88-102. — Subgenital plates of female *Idiostatus* species. 88. *I. californicus,* nr. Plaskett Mdws., Calif. 89. *I. fuscus,* Ralston Pk., Calif. 90. *I. variegatus,* nr. Adrian, Ore. 91. *I. hermannii,* topotype. 92. *I. inermoides,* paratopotype. 93. *I. rehni,* 10 mi. N. Weed, Calif. 94. *I. inermis,* nr. Spencer Lks., Calif. 95. *I. major,* topotype. 96. *I. magnificus,* nr. Donnelly Crk., Nev. 97. *I. elegans,* nr. Rocky Cyn., Nev. 98. *I. bechteli,* paratopotype. 99. *I. martinellii,* paratopotype. 100. *I. apollo,* nr. Pyramid Lk., Nev. 101. *I. apollo,* Donnelly Crk., Nev. 102. *I. birchimi,* 9 mi. W. Lone Pine.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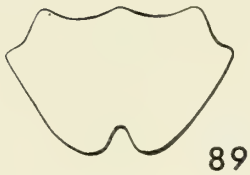
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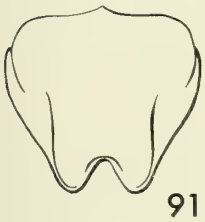
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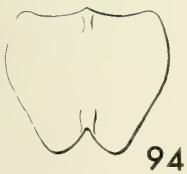
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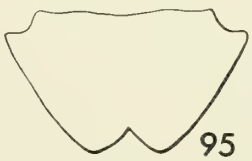
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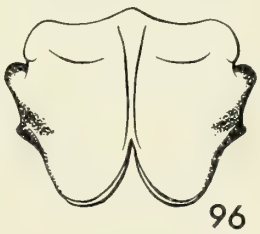
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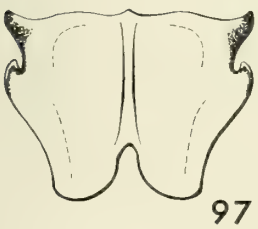
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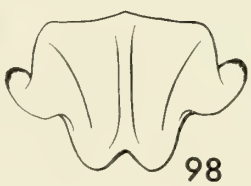
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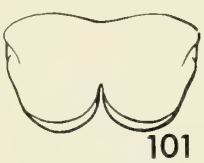
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appear to represent the condition discussed by Hubbell (1936) in that speciation seems to have occurred by differentiation in peripheral areas or environments of specialized offshoots from more generalized parent species. The closest relatives to the above closely related species are those of the *aequalis* Group, the namesake of which can be considered generalized in at least one respect, that of its great ecological latitude.

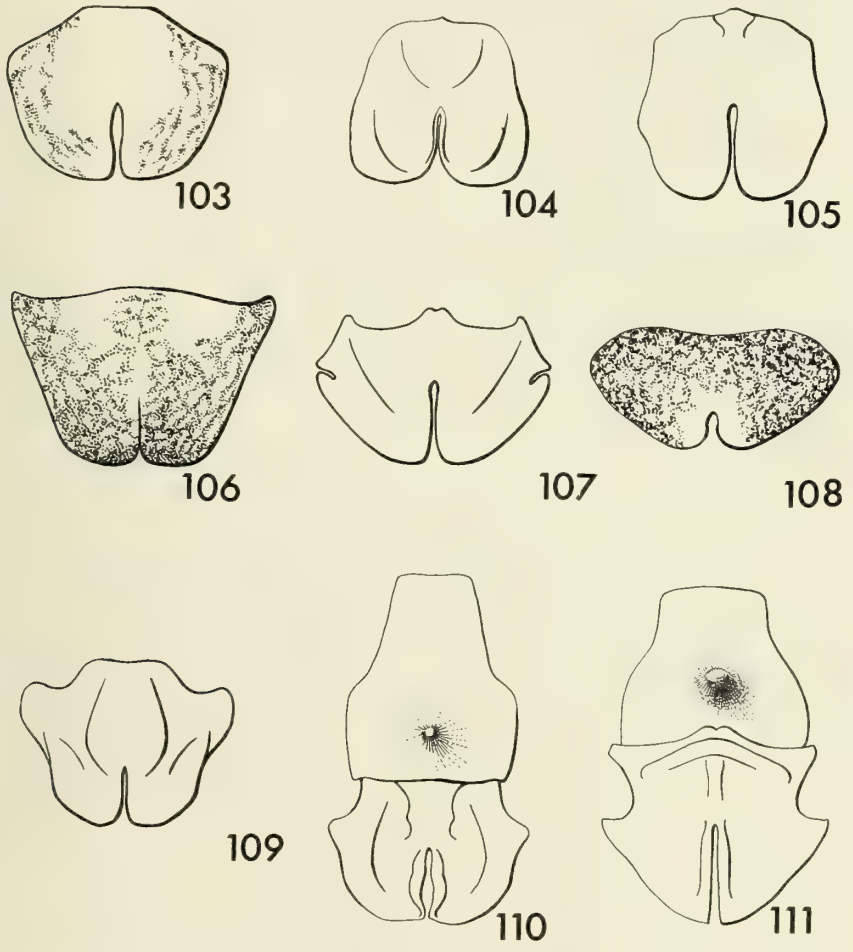
I. kathleenae and *I. middlekauffi* represents the northern-most penetration of the *aequalis* Group in western California. Apparently these species were unable to cross the Sacramento-San Joaquin Delta and the species group is presently stranded in that area.

Of interest in deciphering the distribution patterns of species in the *aequalis* Group is the Mt. Hamilton region, the highest peak in the Diablo Range ascending to 4,372 feet elevation. A considerable number of plants with southern distributions have their northern limits on Mt. Hamilton. This will likely be found to be the case with many insects. The author has collected on both the east and west slopes of that mountain almost every year since the inception of this project, and frequently more than one trip was made during a single season. Not a single representative of *Idiostatus* was seen although seemingly suitable habitats occur there. It thus appears that *I. kathleenae* does not occur to the southwest of the type locality at Arroyo Seco in the Santa Lucia Range or to the southeast in the Diablo Range near New Idria where *I. aequalis* was found. The species is thus evidently solely restricted to the Gabilan Range.

I. kathleenae may not be as good a competitor as *I. aequalis*, the latter of which is found in a wide variety of habitats. The reason for the absence of *I. aequalis* from the Pinnacles area (east side) is still unknown but the area may be too xeric for the northerly populations of that species. This would still not explain the presence of *I. aequalis* at the New Idria locality which seems to this observer to be about as arid as the Pinnacles area.

Biologically *I. kathleenae* is much like the other members of the *aequalis* Group. It is active at night and during the years of peak abundance *Eriogonum fasciculatum* can be searched and several katydids will likely be found on the blossoms. This species seems more abundant during years of higher than average rainfall (1967 collection) and absent during drought years (1965). The court-

ship of the species is similar to that of *I. fuscopunctatus* in that the abdominal stroking phase is omitted.



FIGS. 103-111. — Subgenital plates of females of *Idiostatus* species. 103. *I. inyo*, 8 mi. W. Lone Pine, Calif. 104. *I. callimerus*, topotype. 105. *I. aequalis*, El Segundo dunes, Calif. 106. *I. aequalis*, Lee Cyn., Nev. 107. *I. middlekauffi*, paratopotype. 108. *I. kathleenae*, paratopotype. 109. *I. fuscopunctatus*, nr. Onyx summit, Calif. 110. *I. aberrans*, paratype, nr. Lk. Tahoe. 111. *I. viridis*, holotype.

Idiostatus fuscopunctatus (Scudder)

(Figs. 21, 47, 83, 109, Plates 1, 10)

Cacopteris fuscopunctata Scudder, 1899, pp. 88-89.
Cacopteris punctata (error in spelling), Caudell, 1905, p. 477.
Idiostatus fuscopunctatus, Caudell, 1907, p. 382, figs. 67, 68.
Cacopteris fuscopunctata, Rehn and Hebard, 1920, p. 251.
Idiostatus fuscopunctatus, Hebard, 1934, p. 45.

Type data. — The holotype male is labelled 1. "Tehachapi, Calif., Aug." 2. "A. P. Morse."

Type locality. — The exact type locality is unknown. I have collected at several different locations near Tehachapi and have not found the species but only examples of its relative, *I. aequalis.* Some notes by Morse (1898) indicate the locality where much of his collecting was done was in the open flatlands rather than in the foothills. "Tehachapi. At summit of pass, 4,000 ft. Wheatranches, pasture, foothills, pine forest on mountains. Go up road to mines and forest west of village. Salt Lake six miles south. A good place."

Deposition of holotype. — The holotype is in the Museum of Comparative Zoology, Harvard University.

Diagnosis. — Size medium for species group, form robust. The shape of the cercus and titillators of the male (figs. 47, 109) are unique. Females may be distinguished by the shape of the subgenital plate and the short, abruptly upcurved ovipositor. Characters both sexes share which may be used in species separation include: the distinct pilosity of the dorsal surface of the abdomen, the production of the lateral lobe of the pronotum forming nearly a right angle perpendicular on the anterior margin with the posterior margin dorsally indented, the absence of a dorsal spine on the foramen of the anterior margin of the fore tibia. *I. fuscopunctatus* is an inhabitant of the yellow pine and mixed conifer belt of southern California (fig. 21).

Description. — HOLOTYPE MALE. (Notes taken from examination of holotype.) Size medium for genus. Pronotum deplanate dorsad with median carina weakly indicated. Posterior one-quarter of pronotum with broadly rounded lateral lobes. Tegmen extending beyond pronotum for a distance of slightly less than one-half its dorsal length. Legs spined as follows: fore tibia unarmed dorsally on anterior margin, armed with three spines on posterior margin; ventral surface with six spines on anterior and posterior margins. Middle femur without teeth. Hind tibia with dorsal surface with many spines on inner and outer margins; ventral surface with ten widely spaced spines on inner and outer margins; apex of hind tibia with two spurs on dorsal surface, the inner spur subequal to the outer; ventral surface with four spurs, the inner pair shorter than the outer. Tergite ten broad, deplanate, U-shaped medial incision broad,

less than half the width of the tergite itself. Subgenital plate scoop-shaped, with shallow medial incision; styles three times longer than basal width. Titillator a broad, flat plate, arm scarcely developed, directed ventrad.

Species description. — MALE. Size medium to small for genus, form robust. HEAD with fastigium of vertex well produced, somewhat narrow for the species group. Eyes moderately bulging, not as much as in *I. aequalis,* dorso-ventrally elongate. Frons and genae smooth, sparsely pilose. First antennal segment two and one-half times broader than second. PRONOTUM dorsally deplanate, posterior angles sharply rounded into lateral lobes, without indication of lateral carina. Anterior margin of pronotum slightly concave; posterior margin truncate, not bowed upward; lateral lobe well produced, perpendicular on anterior margin, posterior margin dorsally indented, more than in *I. aequalis;* ventral margin of lateral lobe rather narrow convex. TEGMINA. Left tegmen with left margin slightly obtuse anteriorad, sinuate in posterior, right margin greatly bowed inward in anterior one-quarter, moderately sinuate caudad. Tegmen more developed in this respect than in other species in *aequalis* Group. APPENDAGES. Legs of slightly shorter than average length relative to body, the hind femur protruding for little more than one-quarter its length beyond abdominal apex. Leg spination as described for type. Hind femur unarmed on inner and outer ventral margins, small percentage have a single spine on either margin. Plantula of hind tarsus well defined, small, less than one-quarter length of metatarsus. ABDOMEN dorsally smooth, without indication of median carina. Entire dorsal surface of abdomen pilose. Dorsum of tergite ten somewhat modified (fig. 47), deplanate, somewhat excavated medially, the lateral portions slightly produced as small lobes. Cercus short, only slightly protruding beyond abdominal apex. Subgenital plate slightly longer than broad; V-shaped medial incision shallow, scarcely indicated, if at all. Styles and extremities of subgenital plate sparsely pilose. Titillators as broad plates, arm never produced, apex directed ventrad (fig. 109). COLORATION. Overall color light grey brown, lighter contrasting broad stripe on dorsum of pronotum continuous to apex of abdomen. The head peculiarly marked as follows: fastigium of vertex with broad, black margins. Ventrad of fastigium, median to antennal bases there is an ovoid, light white or creamish yellow spot. Ventrad to the spot are two short, parallel, black stripes separated by a distance slightly greater than one and one-half times the width of the spot itself. Clypeus with two widely separated, small, black spots. Ventral margins of eyes ringed with black. Pronotum with anterior and posterior humeral angles black. Median lateral regions light brown. Tegmina with median area, veins and cells light straw brown. Anterior dorsal region of tegmen in area of dextral bulge, smoky black. Lateral margins of both tegmina light black. Apex of both tegmina light black. Apex of both tegmina with well defined black spot, extending to margin of tegmen. Legs grey, slightly darker at joints. Hind femur with irregular number of stripes on outer pagina at base, with up to three such markings mesad on outer pagina. Outer pagina of hind femur never with even weakly developed longitudinal black stripe. Dorsum of distal tarsal segment of all tarsi with two black spots.

Holotype measurements. — From Scudder (1899:90). Length: body, 14.00; pronotum, 4.50; fore femur, 4.00; hind femur, 14.00.

FEMALE. Similar to male but with following exceptions: size slightly larger, tegmen barely protruding from beneath pronotum. Tergite ten little differentiated, approximately two and one-quarter times longer than broad, with only minor medial incision. Cercus stout for its entire length, not narrowed mesad as in *I. aequalis*. Subgenital plate narrowed basad, expanded to median portion, thence narrowed to apex, incised medially for a distance of slightly less than one-half the length of plate itself. Ovipositor short, distinctly upcurved, with only slight indication of serration or tuberculation on dorsal and ventral margins. Coloration much as described for male. Tegmen with veins light straw brown, cells smoky black. Apex of tegmen with black spot, better defined on some specimens than others. Ovipositor straw brown, apex of valve black.

Variation. — Little variation has been detected in the small series of specimens at hand. Some variation has been seen in the length of the ovipositor (Table 8). The female from Butler Peak, San Bernardino County, California, is slightly darker in overall coloration than the others but this may be due to imperfections in drying.

Chromosome number. — 2N = 29. A male from near Onyx summit, San Bernardino County, California, had the following chromosome complement: 2V + 26R + XV = 29.

EGGS. — Eggs from females collected at the Onyx summit locality agreed with number 77 (medium grey brown) on the ISCC-NBS color chart. See Table 9 for measurements.

Seasonal occurrence. — Late June-25 September.

Song. — The song of *I. fuscopunctatus* is a continuous low buzz (Plate 1) almost identical to the human ear to that of *I. aequalis* and others of the *aequalis* Group. As is the case with most species of the genus, when disturbed during the calling stridulation, the buzz slows to short intermittent "zics."

Distribution. — The discontinuous pattern of distribution of *I. fuscopunctatus* is indicated if the holotype is labelled correctly. The specimens which I collected in San Bernardino County, California, were found in an area between the mixed conifer forest and Juniper-Pinyon woodland between 7,800-8,400 feet elevation. Such an area exists in the mountains to the southwest of the town of Tehachapi and the type may have come from there. Only additional collections will elucidate the real distribution of this species.

Records. — CALIFORNIA: KERN COUNTY: Tehachapi, 2 August ? (A. P. Morse, 1 ♀, holotype, MCZ). SAN BERNARDINO COUNTY: Onyx summit, Hwy. 38, San Bernardino Mts., 8,400 ft. elev., 29 June 1968, matured late July, 1968 (D. C. Rentz, 1 ♂, 2 ♀♀, DCR); 1.5 mi. N. on Hwy. 38, 7,900 ft. elev.,

29 June 1968, matured 9 July 1968 (D. C. Rentz, 2 ♂♂, 2 ♀♀, DCR). Balky Horse Cyn., 3 mi. NE. Onyx summit on Hwy. 38, 7,800 ft. elev., 29 June 1968, matured 24 July 1968 (D. C. Rentz, 1 ♀, DCR). Butler Peak, fire lookout, 25 October 1952 (no collector, 1 ♀, LACM).

Specimens studied. — ten, including holotype.

Hosts. — All of the katydids collected by the author were found in close association with granite gilia (*Leptodactylon pungens* (Torr.) Rydb. subsp. *pulchriflorum* (Brand) (Mason). This is discussed more fully in the following sections.

Discussion. — *Idiostatus fuscopunctatus* is one of the most interesting members of the genus. On the basis of the single collection of nymphs made, the species does not seem rare in nature, but rather highly localized. This likely accounts for the small number of specimens in collections.

The collection of nymphs which I made in 1968 was in a relatively small area, each site separated by only a few miles from the other. The vegetation was largely oak with firs and large, bushy mountain mahogany present in dense stands. Other stops were made along Highway 38 but not a single other representative of this species was encountered. Much *Eriogonum* spp., short-growing species, and *Bromus* sp., probably *tectorum* carpeted the floor of the above localities with a considerable amount of sagebrush, *Artemisia tridentata,* present in the more exposed situations. Nearly all of the young katydids were collected by trampling the rather large herbaceous granite gilia plants which were growing in isolated clones under the oaks and mountain mahogany. Apparently the young nymphs take refuge among the dense foliage of the gilias and do not occur on the other plants. Many other Orthoptera, consisting mostly of grasshopper species, were found at the above localities. These were in order of abundance: *Oedaleonotus enigma* Scudder, *Melanoplus* sp. (short-winged), *Arphia conspersa ramona* Rehn, *Xanthippus olancha* ? (Caudell), *Trimerotropis suffusa* Scudder, *Cordillacris grinnelli* Rehn and Hebard. To the orthopterist the above represents a blending of species from several different vegetation types.

I. fuscopunctatus is a member of the *aequalis* Group being nocturnal and requiring a vertical substrate for courtship. The tegmen has the characteristic black apical spot and the coloration is typical of the species group. The tenth tergite of the male also lacks the

soft membranous medial area possessed by many of the other species groups of *Idiostatus*. Females of *I. fuscopunctatus* possess a shorter than normal ovipositor than is usual for the species group. Of particular note is the absence of the two spines on the anterior dorsal margin of the fore tibia, a unique characteristic of this species. The reduction of the arm of the titillator and broadening of its base is also of note. This latter condition is unparalleled among other known members of the genus. The apex of the titillator is directed downward when viewed *in situ*. This would seem to aid the function of the titillator as a scraping apparatus only when proper copulation has been achieved and the cerci and subgenital plate are firmly locked together. In such a position the apices of the male titillator would then be directed upward in a scraping position.

Four successful matings were observed in the laboratory. Attempts to interest pairs in courtship behavior during daylight hours or at night with the room lights and desk lamps on failed. The observations were made in nearly total darkness with only a microscope lamp or red 25 watt light bulb illuminating the area. In all instances the pair sought a vertical substrate for courtship as described for *I. aequalis*. Most of the time the pair was content to perch upside down on the under surface of the observation screen. Courtship proceeded in the normal manner with palpation followed by direct copulation. At no time was the female's abdomen stroked by the male. See discussion of cross mating experiments with *I. aequalis* under that species.

Although I have not personally collected both *I. fuscopunctatus* and *I. aequalis* together at the same locality, they probably occur together, perhaps in the San Bernardino Mountains as indicated by the collecting records. *I. fuscopunctatus* may be more thamnophilous than *I. aequalis* but the latter is apparently more broadly adapted to both a bush and grass habitat. *I. fuscopunctatus* may in general occur at higher elevations than *I. aequalis*.

Unplaced Specimens

In a study of this nature there are always specimens which for one reason or another cannot be identified with certainty. Rather than exclude these from consideration altogether or "bury" them within the text, I will list them by species groups with locality data

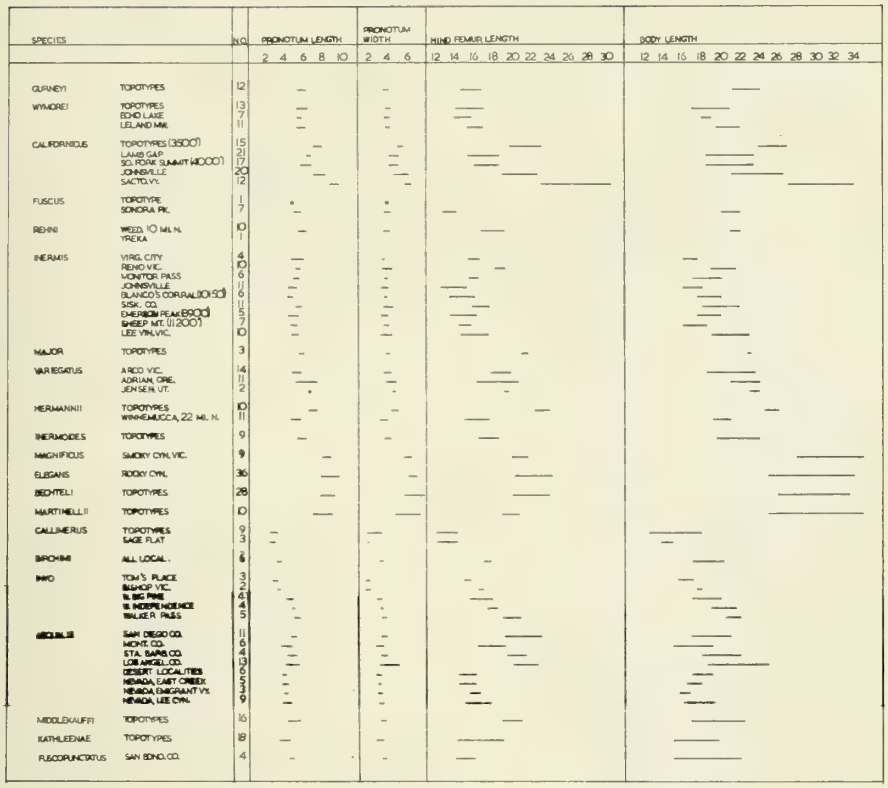


TABLE 7. — Summary of measurements of males in *Idiostatus*. Single points outside the ranges separated by more than 20% of the total range from the nearest measurement in samples under two specimens have been discarded. More complete locality data is available from appropriate sections of the text.

so that future collectors might concentrate in obtaining collections from the areas of interest.

The *hermannii* Group

Idiostatus species

Locality data. — CALIFORNIA: LASSEN COUNTY: Doyle, 16 July 1952 (R. W. Harper, 1 ♀, CDA, ex: range, Cal. Dept. Agr. no. 52C 148).

Discussion. — This specimen is attenuate with a proportionately longer than normal ovipositor for species of the *hermannii* Group. It may actually represent an undescribed species. The cercus is

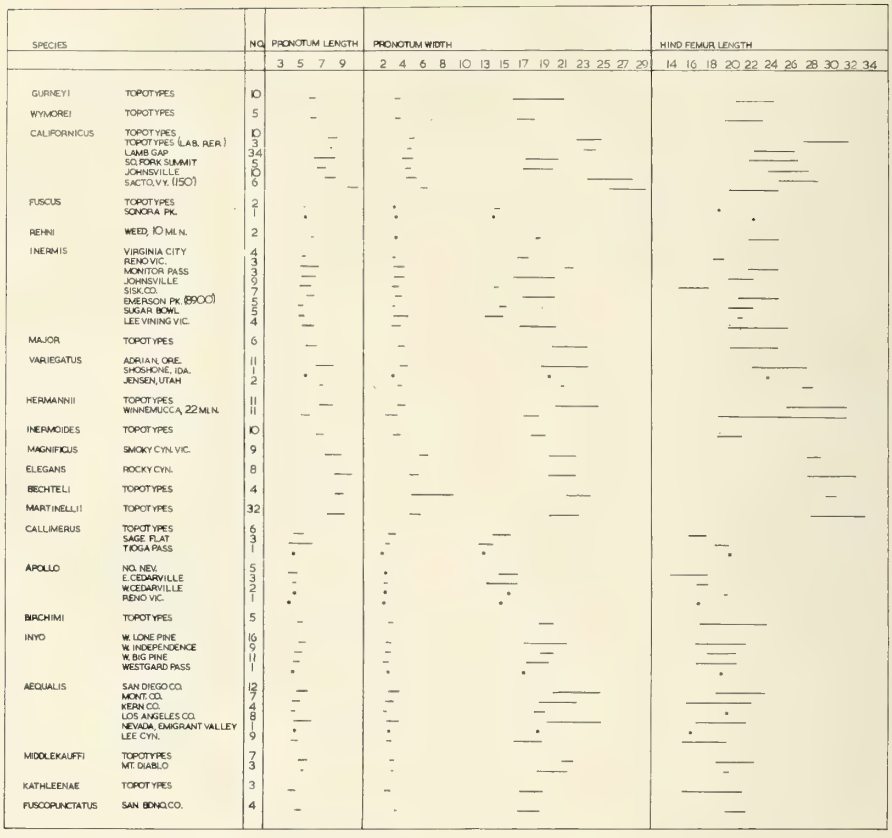


TABLE 8. — Summary of measurements of males in *Idiostatus*. Single points outside the ranges separated by more than 20% of the total range from the nearest measurement in samples under two specimens have been discarded. More complete locality data is available from appropriate sections of the text.

short, apex weakly directed inward.

Measurement. — Length: body, 29.50; pronotum, 7.00; hind femur, 23.40; ovipositor, 27.00.

Idiostatus species

Locality data. — CALIFORNIA: MODOC COUNTY: Cedarville, 17 July 1950 (R. W. Harper, 1 ♀, on greasewood, CDA, Cal. Dept. Agr. no. 50G46).

Discussion. — Although faded and shrunken, this specimen is definitely not *I. hermannii* or *I. inermoides* but could possibly represent the above mentioned species. The ovipositor and cercus and

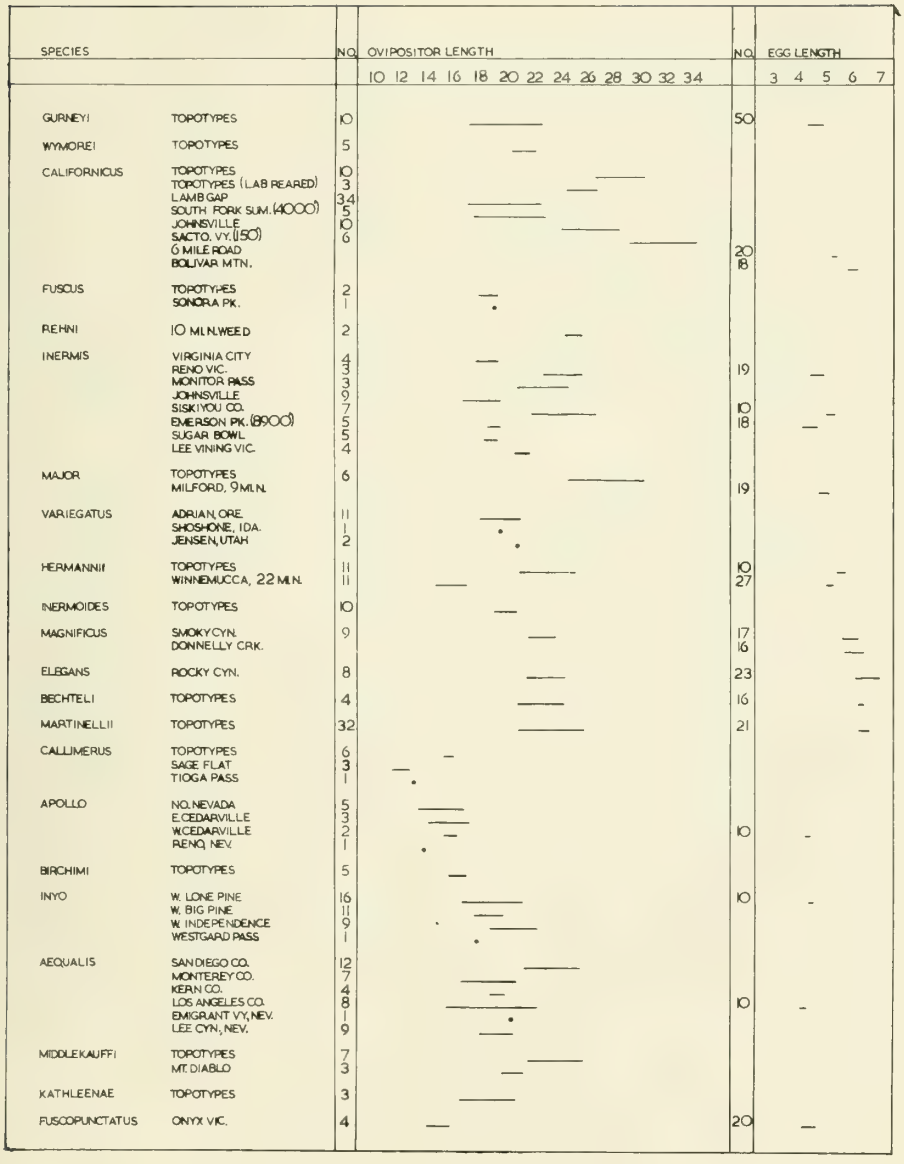


TABLE 9. — Summary of measurements of males in *Idiostatus*. Single points outside the ranges separated by more than 20% of the total range from the nearest measurement in samples under two specimens have been discarded. More complete locality data is available from appropriate sections of the text.

size agree with that specimen. It is of interest that the specimen was collected in almost the precise area of the type locality for *I. martinellii* and where *I. apollo* was found, east of Cedarville (R. W. Harper, personal communication). However, during the "outbreak" year of 1969 no examples of the *hermannii* Group could be located in that area.

Measurements. — Length: body, 26.00; pronotum, 6.20; hind femur, 24.50; ovipositor, 29.10.

Idiostatus species **inermoides** or near

Locality data. — NEVADA: LYON COUNTY: Smith, 3 July 1960 (F. D. Parker, 1 ♂, NSDA, on *Tetradymia*). WASHINGTON: OKANOGAN COUNTY: 6 August 1945 (H. S. Summers, #14, 1 ♂, USNM).

Discussion. — Both males listed above, although geographically separated by many miles are very similar in general appearance. The cerci are remarkably like those of *I. inermoides* as is coloration and size. If the Washington locality is correct, then this is the first record for the genus in that state. Collecting in the Okanogan region in August of 1966 did not yield any specimens but an unusually dry year may have inhibited hatching of eggs. The sagebrush vegetation of the eastern and north central parts of Washington seem suitable for *Idiostatus* species. The Nevada specimen may be an accurate extension of the range of *I. inermoides* but further collecting will be needed to verify this.

Measurement. — Nevada specimen. — Length: body, 21.00; pronotum, 6.10; hind femur, 16.50. Washington specimen. — body, 20.00; pronotum, 5.90; hind femur, 18.50.

The *californicus* Group

Idiostatus species

Locality data. — CALIFORNIA: SIERRA COUNTY: Hwy. 89, 11 mi. S. Sierraville, 4 October 1968 (R. P. Allen, 1 ♀, CDA Cal. Dept. Agr. no. 7191 on *Chrysothamnus*).

Discussion. — The slender female represented above appears to be most closely related to *I. wymorei.* The predominant body color appears to have been grey or brown and this is now faded due to prior preservation in alcohol. The body size is somewhat smaller

than normal for *I. wymorei* specimens and definite placement as to proper species must await further specimens.

Measurement. — Length: body, 21.50; pronotum, 4.80; hind femur, 14.50; ovipositor, 16.40.

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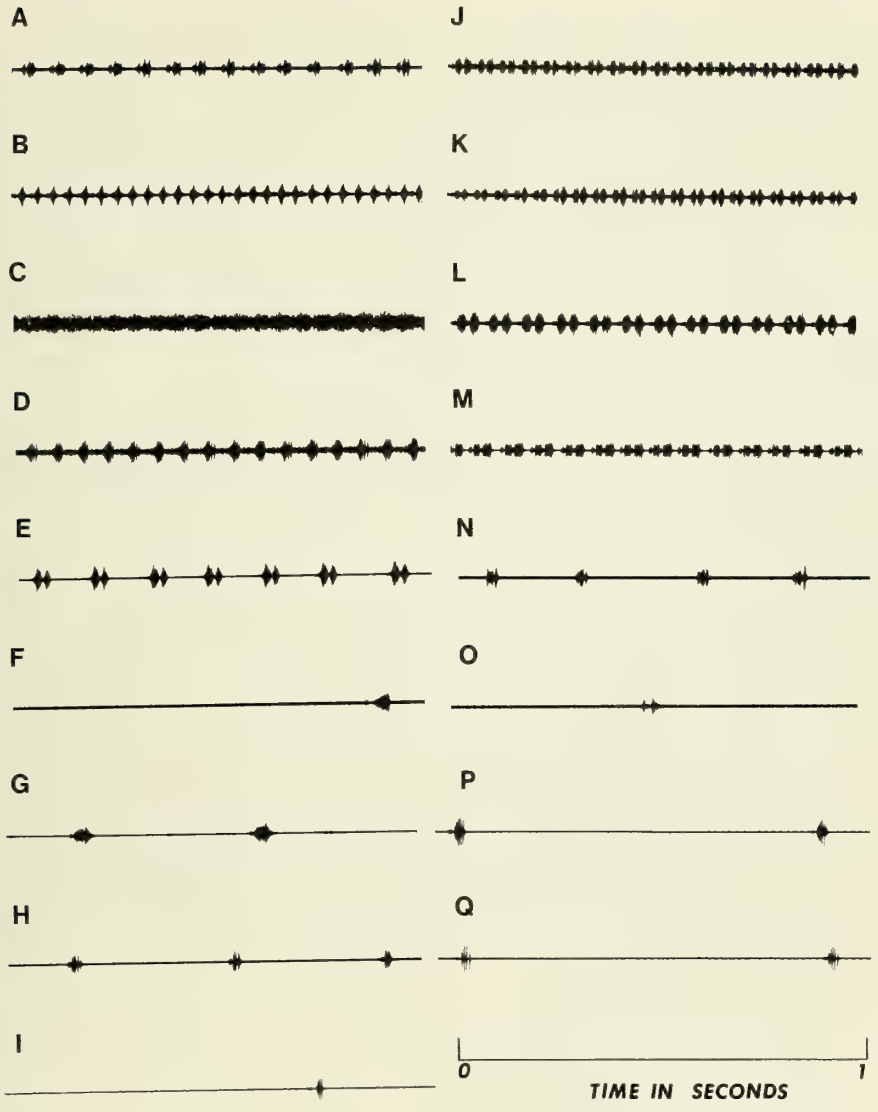
Plate 1. — Oscillograms of song patterns. A-E Calling Songs. A. *I. californicus*, 6 mi. W. Plaskett Mdws., 21.5°C. B. *I. gurneyi*, paratopotype, 25°C. C. *I. inermoides*, paratopotype, 29°C. D. *I. rehni*, 10 mi. N. Weed, Calif., 31°C. E. *Steiroxys* sp. Mt. Lassen, Calif., 35°C. F-I Zic Songs. F. *I. cali-*



fornicus, same data as above. G. *I. inermoides,* same data as above. H. *I. rehni,* same data as above. I. *I. bechteli,* paratopotype, 1.5 secs., 20 cm/sec., 31°C. J-M Calling Songs. J. *I. aequalis,* Jct. Hwy. 23 & Yerba Buena rd., Los Angeles Co., Calif., 27°C. K. *I. aequalis,* nr. Smart's Ranch, S. Bdno. Co., Calif., 27°C. L. *I. fuscopunctatus,* nr. Onyx summit, S. Bdno. Co., Calif., 26°C. M. *I. kathleenae,* paratopotype, 24.5°C. N. *I. inermis,* nr. Convict Lk., Calif., 25°C. O-Q Zic Songs. O. *I. inyo,* 6 mi. W. Independence, Calif., 22°C. P. *I. martinellii,* paratopotype, 31°C, 1.5 secs., 20 cm/sec. Q. *I. magnificus,* nr. Smoky Cyn., 31°C, 1.5 secs., 20 cm/sec.

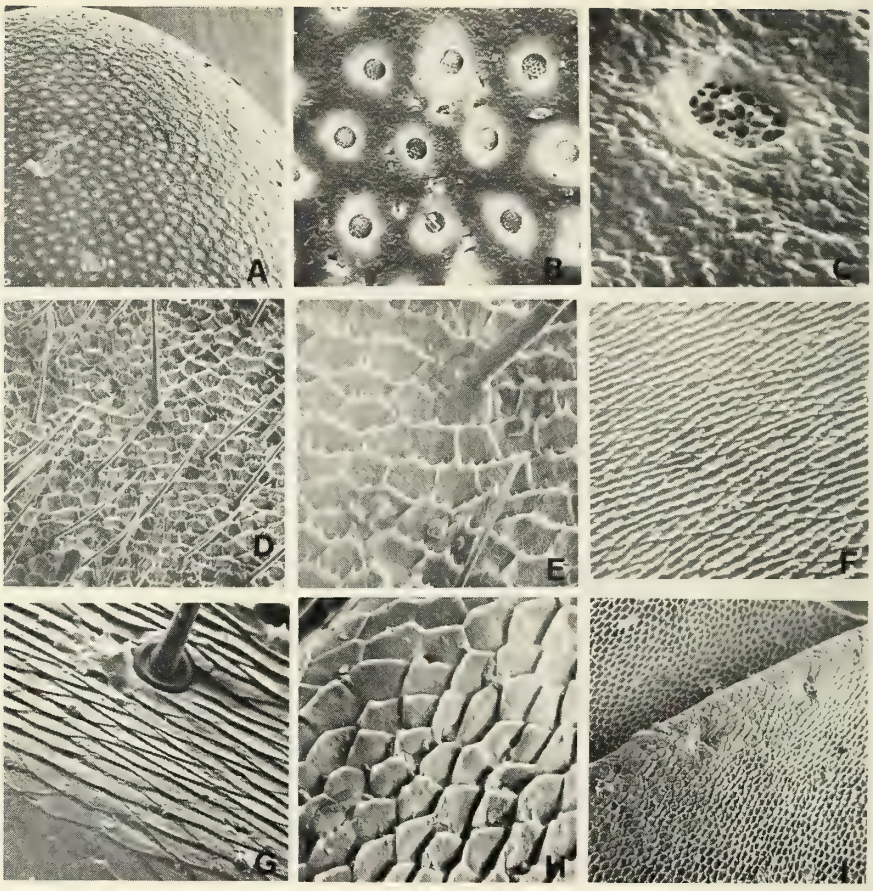


PLATE 2. — Stereoscan electron micrographs. A-C Eggs of *I. inermoides,* paratopotypes. A. Near posterior pole 260X. B. Near anterior pole 1450X. C. Near posterior pole, single pit, 1500X. D-I Dorsal surface of abdominal tergites. D. *I. elegans,* male, nr. Rocky Cyn., Nev., 720X. E. Same area, 1430X. F. *I. elegans,* female, same data as above, 650X. G. *I. hermannii,* male, nr. Rocky Cyn., Nev., 1320X. H. Same area, 1600X. I. *I. hermannii,* same data as above, female, 310X.

PLATE 3. — Top, *Idiostatus elegans,* male; bottom, *I. elegans,* female.

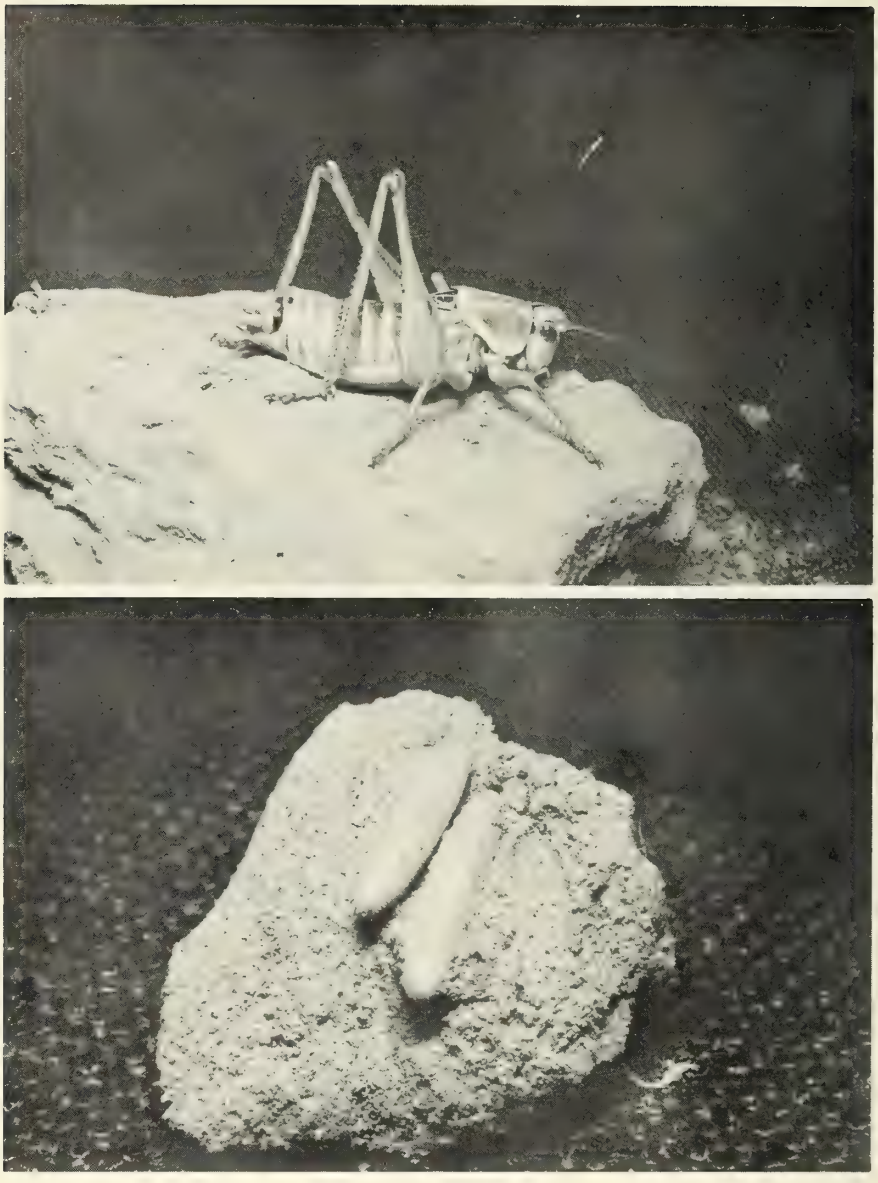


PLATE 4. — Top, *Idiostatus hermannii*, male; bottom, eggs *I. elegans, in situ.*

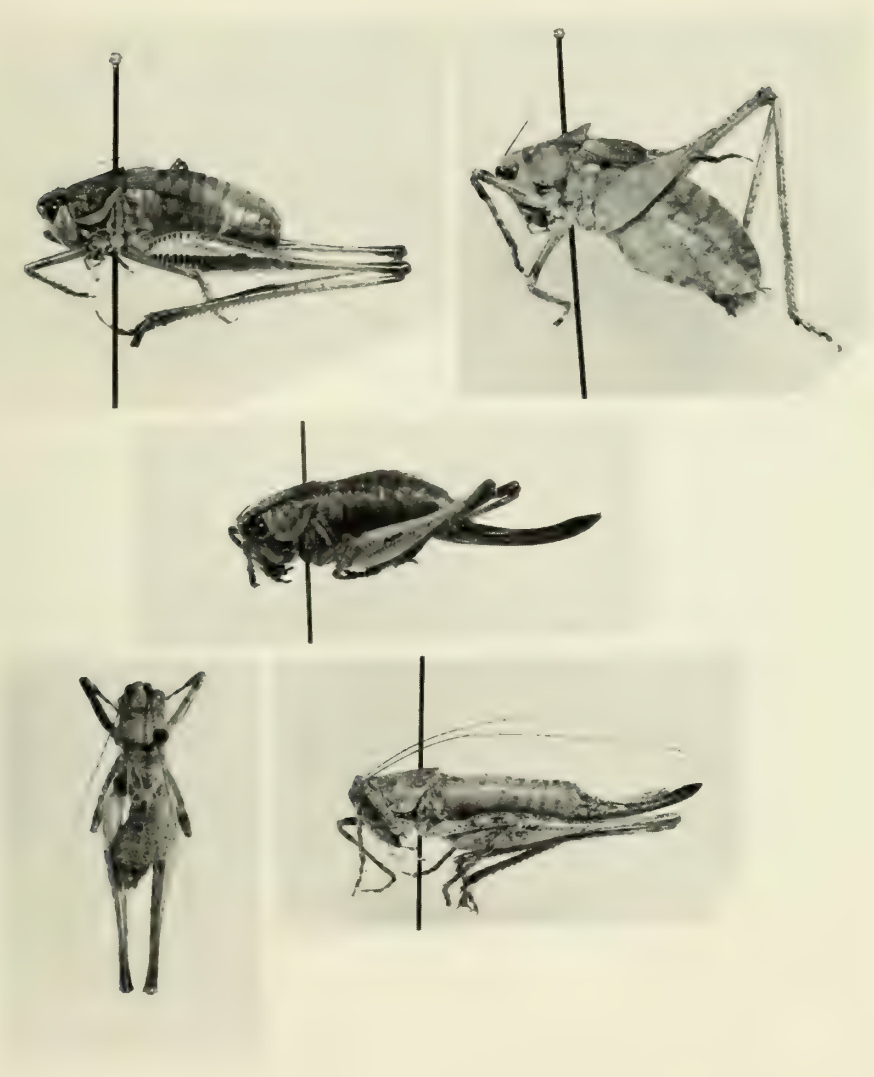


PLATE 5. — Top left, *Uvarovina chinesis* Ramme or near, male nr. Cheefoo, China; right, *Paradrymadusa sordida* Herman, male Delizhan, Armenia; middle, *Eulithoxenus mongolicus* (Uvarov), female Ikh-Bogdo Range, Mongolia; bottom left, male, right female, *Bergiola balchaschica* Uvarov, Askhabad, Turkmenia.

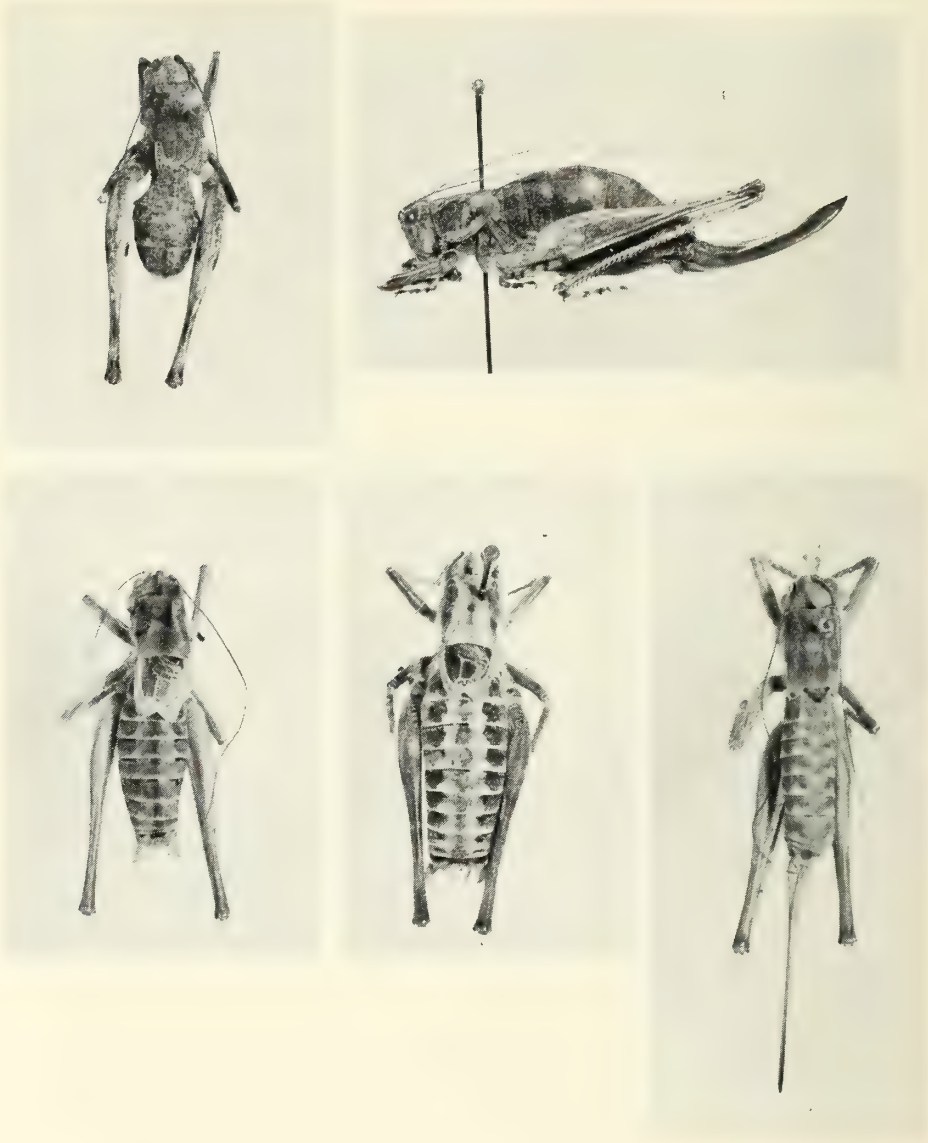


PLATE 6. — Top left male, right female, *Bienkoxenus mongolicus* Mistshenko, S. Gobi, Tost-Ula, Mongolia; bottom left, *Idiostatus variegatus,* nr. Arco, Idaho; middle male, right female, *I. inermoides* paratopotypes.

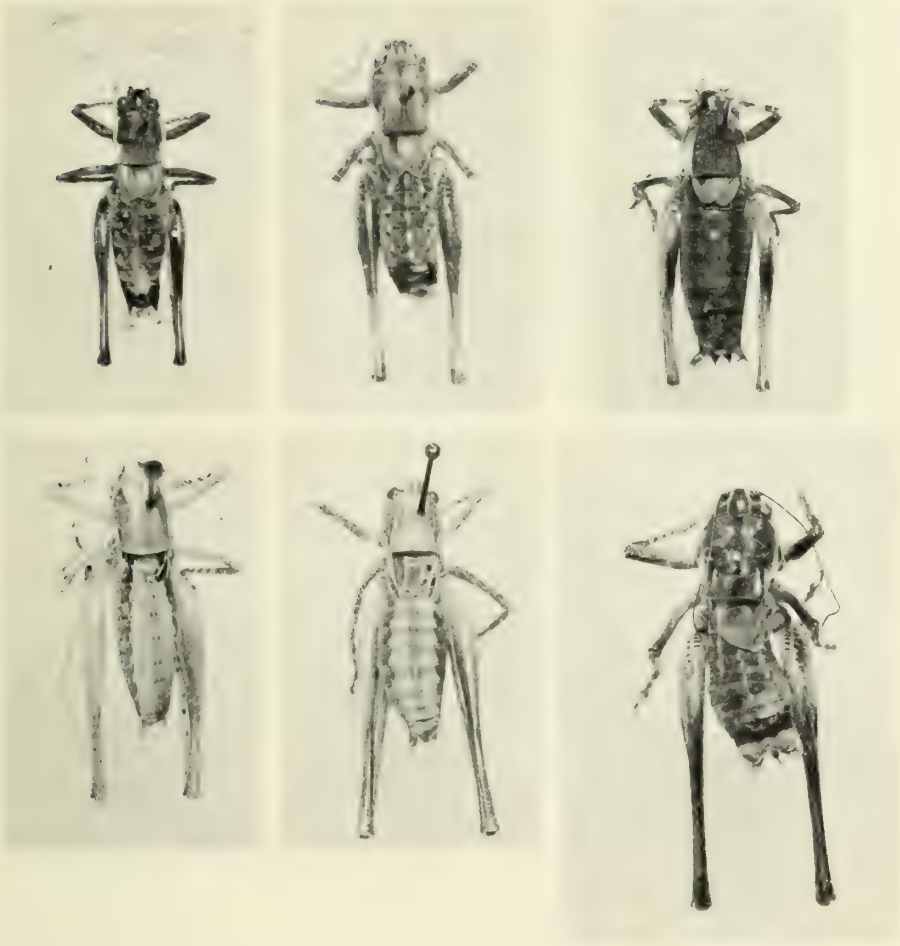


PLATE 7. — Top left, *Idiostatus rehni,* male, 10 mi. N. Weed, Calif.; middle *I. inermis,* male, nr. Reno, Nev.; right, *I. gurneyi,* male, paratopotype; bottom left, *I. apollo,* male, nr. Donnelly Crk, Nev.; middle, *I. birchimi,* male, paratopotype; right, *I. major,* topotype male.

PLATE 8. — Top left, female, middle male, *Idiostatus bechteli,* paratopotypes; right, *I. magnificus,* male, nr. Smoky Cyn., Nev.; bottom left and middle, holotype, *I. magnificus,* right, *I. martinellii,* male, paratopotype.

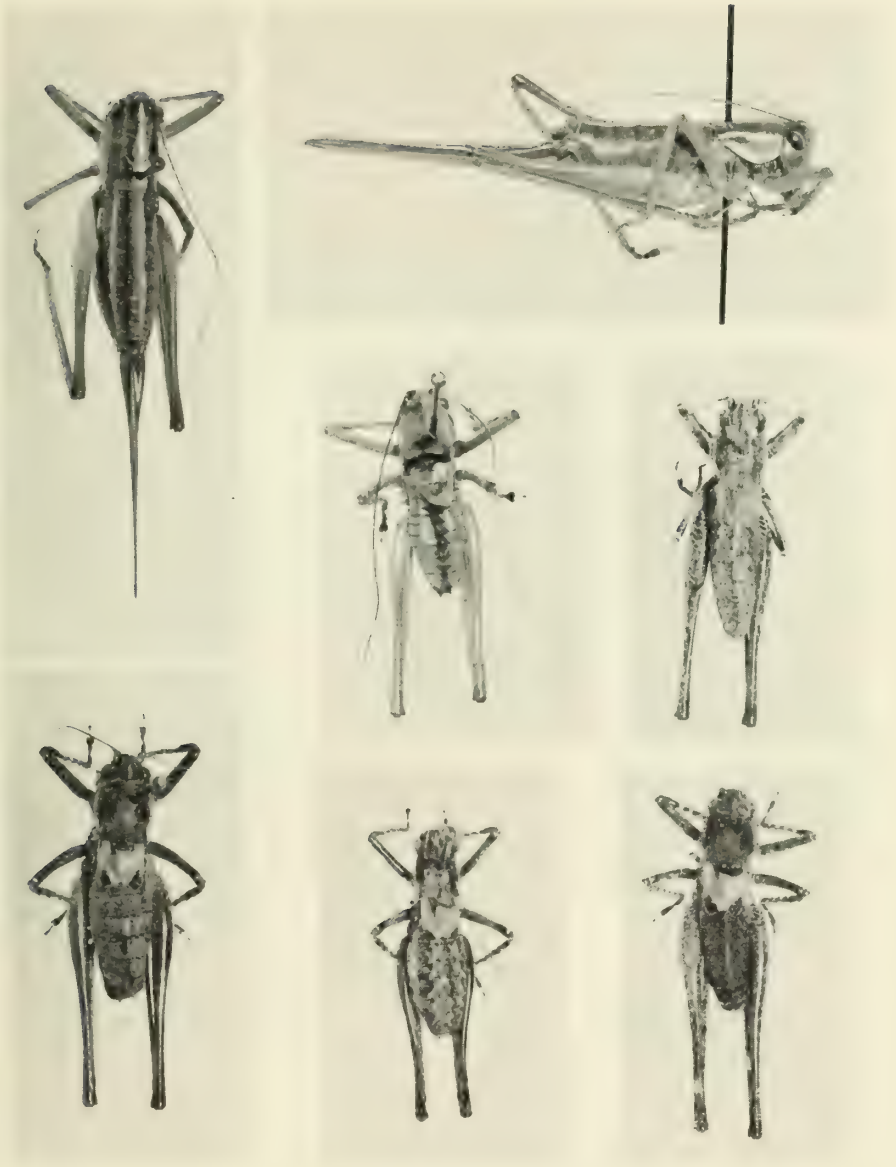


PLATE 9. — Top left and right, *Idiostatus viridis,* holotype dorsal and lateral views; middle left, *I. aberrans,* holotype; right, *I. inyo,* male, 6 mi. N. Independence; bottom left, *I. aequalis,* male topotype; middle, same species, male nr. McGill, Nev.; right, *I. kathleenae,* male paratopotype.

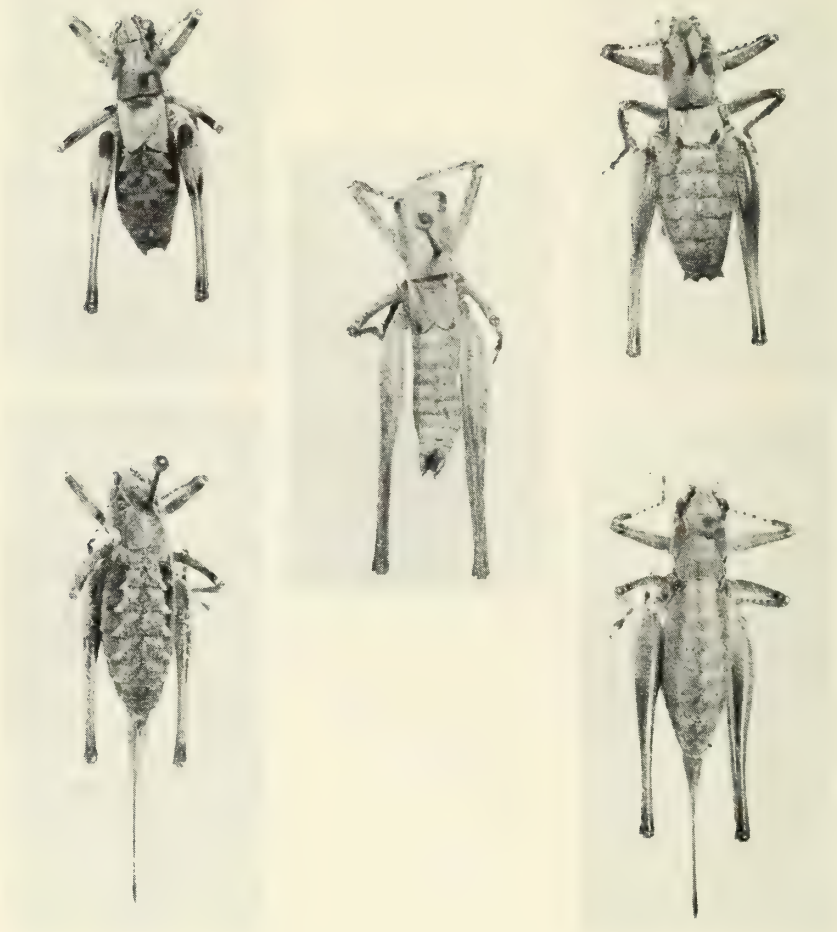


PLATE 10. — Left, top male, bottom female *I. callimerus,* topotypes; middle *I. middlekauffi,* male, paratopotype; right top, male, bottom female *I. fusco-punctatus,* nr. Onyx summit, Calif.

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